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Newsletter edited by Markus Aretz with the assistance of Barry Richards and Svetlana Nikolaeva.

Thanks to all colleagues who contributed to this newsletter!

Cover Illustration:

Carrizo Arroyo, central New Mexico showing Pennsylvanian-Permian transition (dashed line marks boundary). The locality was visited on May 19, 2013 during the Carboniferous-Permian Transition conference held at Albuquerque, New Mexico in May 2013.This is one of the most paleontologically diverse localities across the Carboniferous-Permian boundary. It exposes the upper part of the marine Atrasado Formation and overlying mixed marine and nonmarine strata of the Permian Bursum Formation that yield everything from plants and insects to fusulinids and brachiopods. This section plays a key role in global marine/non-marine correlations because of the co-occurrence of conodonts and insect-zone species.

(Photo courtesy of Barry C. Richards)

EXECUTIVE'S COLUMN

Dear Fellow Carboniferous Researchers,

Introduction

The goal of the executive's column is to introduce subcommission members to some of the important current events and transactions with within the subcommission. In this edition of the report, the main items discussed are changes to our website, the financial statements in the Annual Report for the last fiscal year, results of last year's meetings, and information about our conference/field workshop schedule for the current fiscal year along with themes and anticipated results.

Website

During the Nov. 1st, 2012 to Oct. 31st 2013 fiscal year, the SCCS revised its official website http://www.stratigraphy.org/carboniferous/. The present site has eight main pages containing the following information: 1) Homepage - introduction and links to other pages; 2) Organization - lists of SCCS officers, voting members, corresponding members, and working/task groups and their leaders; 3) Announcements - lists forthcoming meetings and other news; 4) Publications - provides links to downloadable pdf files for the Newsletters on Carboniferous Stratigraphy and latest Annual Reports submitted to the ICS by the SCCS Working Groups; 5) SCCS Tasks - outlines overall objectives and fit within IUGS science policy; 6) GSSPs - provides chart showing shows ratified GSSPs and those in progress in the Carboniferous and provides links to relevant literature and photographs; 7) Time Scale - Provides the Carboniferous Time scale used by Davydov et al. (2012) in the Geological Time Scale 2012, a recently published paper about the current status of the Carboniferous time scale (Richards, 2013), and a pdf file of PowerPoint presentation about Current Status of Carboniferous Time Scale; and 8) Fossils of the Month - provides illustrations and pdf files for papers about fossils used in boundary definition.

Financial statements for the Nov. 1st, 2012 to Oct. 31st 2013 fiscal year

Financial statements for the last fiscal year are included in this issue of the Newsletter on Carboniferous Stratigraphy in the summarized version of the 2013 Annual Report that the SCCS submitted to the International Commission of Stratigraphy (ICS). In the report, the summary of expenditures for 2013 (statement of operating accounts Nov. 1st, 2012 to Oct. 31st 2013) is somewhat anomalous in that it shows the subcommission did not receive an operating grant from the ICS for that fiscal year and there were no expenditures during the year. The operating grant for last year was, however, eventually sent with the operating grant for the current fiscal year and we anticipate there will be expenditures during this year. On May, 4th, 2014, the SCCS chairman received a grant of $2,333.00 in US dollars (= $2,482.31 Canadian) from Stan Finney, chairman of the ICS. The funds carried forward into the current fiscal year on October 31st, 2013 were $706.62 in Canadian dollars.

Stan Finney likes the voting members and task-group leaders of the ICS subcommissions to hold regular workshops and field meetings related to the principal mandates of the ICS and its subcommissions. A substantial component of our annual grant usually goes toward providing some logistic support for our members to attend such meetings. Unfortunately, very few members request any of the available money from the executive and we currently hold a balance of $3,188.93 in Canadian dollars. Each fiscal year, we should use most of the money we receive through donations and ICS grants for SCCS conferences, workshops and field activities. By the end of a fiscal year, if we incur a substantial balance like we have now, the size of the ISC grant we will receive for the subsequent year will be correspondingly reduced. If you require any financial support, even a couple of hundred dollars, to attend any of the main meetings and workshops directly related to the mandate of the SCCS in this fiscal year please ask me for a small grant. Some funds can also go toward supporting field activities. The requests will be kept confidential unless you want them to be publicized in the Newsletter on Carboniferous Stratigraphy. Also, you can ask for the grant either before or after the meeting or field activity for which it is intended, but please make your request within the fiscal year.

Results of last year's meetings

During the November 1st 012 to October 31st 2013 ICS fiscal year, we held two main SCCS workshops and meetings. The first of the meetings was titled "The Devonian and Lower Carboniferous of northern Gondwana" and it was an International Field Symposium of the Subcommission on Devonian Stratigraphy (SDS), SCCS, and Task Group for the "Devonian–Carboniferous Boundary". The dates were March 23rd to 30th, 2013 and it was held in Morocco at the Palm's Hotel in the city of Erfoud. The field trips were to Devonian and Mississippian outcrops in the Tafilalt region of the Anti-Atlas Mountains. The second of the meetings was "The

Carboniferous-Permian Transition", an International Field Symposium of the SCCS and Subcommission on Permian Stratigraphy (SPS). Dates for the latter meeting were May 20th to 22nd and it was hosted by the New Mexico Museum of Natural History and Science in Albuquerque, New Mexico, U.S.A. The museum provided a wonderful venue for the Albuquerque meeting and the field trips were to localities near Albuquerque and by the city of Socorro.

SDS/SCCS conference and field meeting in Morocco

The culturally and scientifically exciting Erfoud meeting, organized byTomas Becker and colleagues at the Institute Scientifique, University Mohammed V – Agdal, Rabat, Morocco, was of particular relevance to the activities of the SCCS task group established to redefine the Devonian-Carboniferous boundary. Two main publications arose from the meeting: EL HASSANI, A., BECKER, T. & A. TAHIRI (eds.) (2013): International field symposium "The Devonian and Lower Carboniferous of northern Gondwana. — *Document de l'Institute Scientifique, Rabat*, No **26**, 2013, 134 p. and BECKER, T., EL HASSANI, A., & A. TAHIRI (eds.) (2013): International field symposium "The Devonian and Lower Carboniferous of northern Gondwana. — Field Guidebook, *Document de l'Institute Scientifique, Rabat*, No **27**, 2013, 150 p.

The task group to redefine the Devonian-Carboniferous boundary held a business meeting at Erfoud and the researchers agreed on several points that are summarized below and should provide guidelines for further activities and discussions. 1) All potential criteria for the D-C boundary definition require study. The new boundary definition does not need to be a conodont. 2) A multidisciplinary approach should be used for boundary definition. The presence or absence of a single criterion cannot be the only argument for placing the boundary. 3) If the boundary level has to be changed, it should not be raised into the Tournaisian. 4) The major late Famennian extinction (Hangenberg Event) is a good potential candidate for a new definition of the boundary, but additional detailed stratigraphic data are required before it can be used.

The Carboniferous-Permian Transition meeting

The Carboniferous-Permian Transition meeting in New Mexico, organized by Spencer Lucas and colleagues at the New Mexico Museum of Natural History and Science, included two and a half days of oral and poster presentations at the museum in Albuquerque and 4.5 days of field trips in the Albuquerque and Socorro regions of New Mexico. The field guides were published in one of the two outstanding proceedings volumes along with several stratigraphic papers about the Carboniferous and Permian of New Mexico (LUCAS, S.G., NELSON, J.W., DIMICHELE, W.A., SPIELMANN, J.A., KRAINER, K., BARRICK, J.E., ELRICK, S. & S. VOIGT (eds.) (2013a): The Carboniferous-Permian transition in central New Mexico. NewMexico Museum of Natural History and Science, Bulletin 59, 389 p.). Members of several SCCS and SPS task groups along with corresponding members also presented the results of their recent work and their abstracts along with associated manuscripts in the second of the two conference proceedings volumes (LUCAS, S.G., NELSON, J.W., DIMICHELE, W.A., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.) (2013b): The Carboniferous-Permian transition. New Mexico Museum of Natural History and Science, Bulletin 60, 465 p.).

Members of the SCCS and SPS held a joint business meeting at the Albuquerque conference and some of the agenda items relevant to the SSCCS are outlined herein. Perhaps the most important agenda item was the establishment of a new joint working group involving the two subcommissions. The chairs of the Subcommissions on Carboniferous and on Permian Stratigraphy, Barry Richards and Shuzhong Shen, agreed to organize a joint working group on the global correlation between Carboniferous and Permian marine and nonmarine deposits. Professor Jörg W. Schneider: (Joerg.Schneider[at]geo.tu-freiberg.de) volunteered to chair the new working group. As the kickoff for that working group, a Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation will be held at the Technische Universität Bergakademie Freiberg in Germany from July 21 to July 27, 2014.

A second important agenda item at the Albuquerque business meeting was a discussion about publishing a special issue of the Bulletin of the New Mexico Museum of Natural History and Science that would be devoted to Carboniferous stratigraphy and events. Immediately prior to the New Mexico meeting and during the meeting, Spencer Lucas, a vertebrate paleontologist at the museum and editor-in-chief of Bulletins 59 and 60 published for the conference, asked me (SCCS chairman) if the subcommission would be interested in publishing a volume devoted to topics related to Carboniferous stage-boundaries and GSSPs. A number of topics and titles for the bulletin were briefly discussed and a suggested title was – Carboniferous GSSPs, events and stratotype sections. Spencer Lucas thought that members of the Carboniferous Subcommission had a substantial volume of unpublished material that could be complied in such a volume and offered to publish one for us. The unpublished material includes several papers that were being prepared for the

Albuquerque meeting but were not completed on time, unpublished manuscripts related to presentations given at the XVII International Congress on the Carboniferous and Permian held in Perth, Australia in 2011, results of ongoing boundary studies undertaken by the various SCCS task-groups and presented as progress reports and summary papers in the Newsletter on Carboniferous Stratigraphy, and manuscripts arising from presentations and discussions at the 2013 Devonian and Lower Carboniferous of northern Gondwana conference in Erfoud, Morocco. The advantages for us are there would be no publication cost to the subcommission, the bulletin would be printed as hard copy and digital on-line version, and it could be compiled, edited and published over a short period (about two years). Spencer would assist with editing the volume but most of that work must be completed by the SCCS. As chairman of the SCCS, my main concern with the proposal was that we might not have enough material available to get such a bulletin ready in a short period of time and that a substantial amount of work would be required by the authors and editors. Another question that arose was would our members be willing to commit their time contribute to such a bulletin. Some members present indicated they liked to publish in higher profile journals and special publications such as those of the Geological Society of London, University of Cambridge Press (Geological Magazine), and the Palaeontological Association (Paleontology). At the end of the discussion, I thanked Spencer Lucas for making the offer, told him I thought it was an exciting opportunity to get a large volume of material published, and indicated we would see if our membership was interested in contributing to such a volume.

2014 Conference and field-workshop schedule with themes and anticipated results

Freiberg conference

During the November 1st, 2013 - October 31st, 2014 fiscal year, the only official SCCS conference and field meeting will be a joint one with the Subcommission on Permian Stratigraphy (SPS) – Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation from the 21 – 27 of July 2014 in Freiberg, Germany. The announcement for the meeting is included in this newsletter under Meetings and the first circular has already been sent to most of the membership.

The aim of the meeting is to bring together all colleagues who are interested in the correlation of Carboniferous, Permian and Early Triassic continental deposits with the global marine succession. The subject of the meeting will be the use of any and all correlative age-relevant data from marine and nonmarine deposits for the solution of the above mentioned problem. In particular, the workers from the various continental basins are asked to promote their detailed local and regional knowledge toward our global aims.

XIVIII International Congress on the Carboniferous and Permian

During the November 1st, 2013 – October 31st, 2014 fiscal year, there will be several Russian field meetings in preparation for the XIVIII International Congress on the Carboniferous and Permian (ICCP), which will be held in Kazan, Russia in the summer of 2015 (Dates: August 7th–15th, 2015). The SCCS will hold a general business meeting at the conference; in addition, all of the SCCS task groups will be holding workshops and business meetings at the ICCP, our most important quadrennial meeting. This summer, a major focus for most task groups will be the completion of field work in Russia in preparation for the conference field-trip guides and technical-session presentations. For additional information about the meeting see the official congress website at http://kpfu.ru/iccp2015 and the second circular, which is included in this issue of the newsletter and has been posted on our SCCS website.

Newsletter on Carboniferous Stratigraphy

Unfortunately, there is no volume of the Newsletter on Carboniferous Stratigraphy with a 2012 publication date. Volume 30 of the newsletter was assembled in late 2012 and early 2013 but when it was completed it was well into to 2013 so we decided to give volume 30 a 2013 publication date. During the last couple of years, we found it difficult to get the newsletter published by the end of the calendar year because many of the task-group progress reports and other manuscripts were submitted late. Contributions for the newsletter must be submitted to Markus Aretz by October 31st in order to provide sufficient time for the articles to be reviewed, edited, and formatted for publication during the early part of the next calendar year.

The Newsletter on Carboniferous Stratigraphy is an ideal venue in which to present the preliminary results of Carboniferous studies. During the last several years we have received numerous short journal-style articles that are highly relevant to our principal mandate – the establishment of GSSPs for the Carboniferous and its main subdivisions – and we wish to thank our members and their colleagues for submitting them. We need to continue to receive such manuscripts for future issues of the newsletter but encourage our membership, particularly the corresponding members, to submit short progress reports about any aspect of their current Carboniferous studies. The progress reports should be similar to those submitted annually by the official

SCCS task groups and provide some preliminary results along with illustrations and plans for future work and publications. The purpose of such reports is to inform our voting members and task-group leaders about activities and studies that might be directly relevant to the principal ICS mandate. The newsletters of several of the other ICS subcommissions typically contain a number of such summary articles. Submission of such reports will also help us keep in touch with our membership. The subcommission has hundreds corresponding members from whom we never receive contributions and we would like to see greater involvement by them in SCCS activities. Our individual task-group members are also encouraged to submit boundary-related progress reports.

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OBITUARY

VLADIMIR NIKOLAEVICH PAZUKHIN (20TH JUNE 1951-30TH JUNE 2013)

45 years of work in the Institute of Geology, Ufa Research Center, Russian Academy of Science, Ufa, Bashkortostan

Vladimir Pazukhin (Volodya), a scientist with a world-wide reputation for his expertise on Devonian and Carboniferous conodonts, and an excellent stratigrapher and geologist passed away after a long illness on June 30th shortly after his 62nd birthday.

Vladimir graduated from the Department of Geology and Geomorphology, Geographical Faculty of the Bashkirian State University in 1974. He became interested in geology while at school, when he joined a young geologists' club led by Igor Nikolaevich Semenov. He worked for the Institute of Geology from 1968, starting his research work at the institute while still a university student. He was employed by the Laboratory of Paleozoic Stratigraphy, then led by V.A. Maslov, who suggested that Vladimir Nikolaevich should work on conodonts, then a new and promising group of fossils. Studying conodonts became his life-long research. Vladimir applied himself to this work with great enthusiasm. He dissolved vast quantities (many tons) of samples and assembled an exceptional conodont collection. In the absence of technicians he himself worked in the lab extracting and picking out conodonts.

Vladimir Pazukhin in the Museum of the St. Petersburg Mining Institute in 2006.

At the beginning of his career Vladimir worked on the D-C boundary problem with N.M Kochetkova, L.I. Kononova, and E.A. Reitlinger. Specialists of this team substantiated the position of the D-C boundary in the Urals at the base of the Gumerovian Regional Substage. In 1989 he received his PhD degree for his thesis "Tournaisian conodonts of the Urals" from the Department of Paleontology of the Moscow State University. In 1994 he earned the title of Senior Researcher. He developed a phylogeny of the genus *Siphonodella*, which is of paramount importance for Tournaisian stratigraphy, based on material from the South Urals. Vladimir made important contributions to the updated stratigraphic scheme of Carboniferous successions in the Urals, while preparing for the 4th Uralian Interdepartmental Stratigraphic Conference (1988-1991). He participated in many joint expeditions and excursions, e.g., in the Omolon Massif, Kitab Reserve in Uzbekistan, the Donets Basin, and the Middle Urals.

In the 1970s-1980s Vladimir worked on joint projects with the Chelyabinsk Geological Mapping Expedition and took part in field work with geologists of the Magnitogorsk Geological Mapping Group, including A.V. Yarkova, V.M. Moseichuk, A.G. Ryzhov and L.V. Kashina studying sections of carbonate, clastic-carbonated, and volcanic-sedimentary Carboniferous sections of the Magnitogorsk Megasynclinorium. Vladimir's major and systematic conodont extraction from numerous samples of carbonates, even including marbles, allowed recognition of regional substages in the Famennian and Lower Carboniferous of this region. Using these and other paleontological data, geologists of the Magnitogorsk Geological Mapping Group established the volcaniclastic Shumilino Formation and the Carbonate Formation of Magnitnaya Mountain (Famennian-Tournaisian boundary beds, Kosvian Regional Substage).

Vladimir Pazukhin on a field trip in the Urals.

In the Istitue of Geology, Vladimir was mainly involved with the development of the stratigraphic scales of the Carboniferous System. He developed a conodont zonal scale for the Lower Carboniferous of the Urals, which was used for the conodont zonal scale of Russia (Pazukhin, 2009), and based on conodonts he substantiated an updated stratigraphic scheme of the Bashkirian Stage approved by the Interdepartmental Stratigraphic Committee of Russia in 2006. From 2006, Vladimir, now a part- employee of the Institute of Geology, started his job at "BashNIPIneft" (Bashkirian Research and Design Petroleum Institute). Vladimir was particularly interested in the substantiation of the Viséan-Serpukhovian boundary in the Verkhnyaya Kardailovka section, which has been proposed as a candidate GSSP for the base of the Serpukhovian. He started his research at this section in 1976, was the first to systematically excavate several trenches, sampled the succession and processed rocks for conodonts. This work culminated with the publication of several papers on the Verkhnyaya Kardailovka section (Pazukhin *et al*., 2002, 2009; Pazukhin and Gorozhanina, 2002). In one of his most recent papers he described the Late Viséan and Serpukhovian conodonts of the South Urals (Pazukhin, 2011).

Vladimir took part in many scientific projects, including projects funded by the Russian Foundation for Basic Research «Choice of Sections and Biostratigraphic Substantiation of Global Stratotypes of the Viséan-Serpukhovian Boundary (Lower Carboniferous)» (2004–2006), «Middle Carboniferous of the Urals and Russian Platform: Stratigraphy, Biozonal Correlation» (2007–2009), «Type and Reference Sections of the Lower Carboniferous of the South Urals and the Russian Platform: Biostratigraphy, Global Correlation, GSSP» (2010–2012).

Vladimir Pazukhin At the 2009 International Excursion to the type Carboniferous sections, Russia.

From 2003 Vladimir was a member of the Devonian and Carboniferous Commissions of the Interdepartmental Stratigraphic Committee of Russia. He also participated in the elaborating of the International Chronostratigraphic scale of the Carboniferous System, and was a member of three Task Groups of the ICS: on the revision of the base of the Carboniferous, on the choice of GSSPs for the base of the Serpukhovian and Moscovian stages. While working in "BashNIPIneft" Vladimir Nikolaevich obtained new data on the stratigraphy of Bashkirian Cisuralia. He was the first to substantiate the Bashkirian-Moscovian boundary in this region at the base of the *Declinognathodus donetzianus* conodont zone, and studied the biostratigraphy of the Upper Frasnian in different facies (depression, slope, and reefal).

Vladimir obtained important results from boreholes in the Orenburg Region. Using conodonts he recognized the Emsian (Vyazovian-Koivian Regional Substages), Eifelian, Frasnian and Famennian intervals in deep-water facies in the

marginal area of the Peri-Caspian Basin. He was the first to obtain and characterize conodonts from boreholes in the Tournaisian, Viséan, Bashkirian, and Moscovian deposits in that area.

Volodya was a highly motivated scientist, who worked with great inspiration and passion. He often forgot about time and worked tirelessly beyond his working hours. He was a careful and thorough researcher, who never cut corners and wanted to be absolutely certain of his conclusions.

Volodya was a very optimistic person. He recognized the positive things of life, and solved problems with a smile. He was a devoted friend and a good companion. He was also a very good chess player, and very few of his colleagues could beat him. He loved nature and took great care of his garden. On his desk at work, he had a lemon plant grown from a seed, which now produces fruit. Volodya's untimely death is a colossal and irreparable loss for Uralian geology, and for Devonian and Carboniferous stratigraphers in particular. We lost the only specialist on Carboniferous conodonts in the Middle and South Urals, fanatically and utterly dedicated to his research, at the peak of his scientific career. We will always remember him not just as a major scientist, but also as an experienced, calm, balanced and reliable friend and colleague in field and laboratory research, on whom we could always rely.

Volodya's friends and colleagues wrote about him:

"*Volodya was hard-working, a responsive friend, and in the last years he, I think, re-examined his entire collection. He was a fighter" (Lemuza Akhmetshina).*

"I am so sorry, and I am utterly upset. He was my good friend, a fantastic person…" (Yurii Gatovsky)

"…I was always touched by his tact, modesty and understanding of other people's problems" (Svetlana Nikolaeva)

I have no words to describe my grief about this untimely loss of an excellent person and scientist" (Rimma Ivanova)

"This is a big loss, he was a very good geologist and it is a pity he cannot continue his work" (Jiri Kalvoda)

"I am very, very sorry. He was a great man and good geologist" (Elham Asadi)

Many others sent their condolences sharing this deep feeling of having suffered a major loss.

Vladimir Pazukhin co-authored three monographs and published over 100 papers. Below we list some of his contributions.

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REPORT FOR THE CONFERENCE: THE CARBONIFEROUS-PERMIAN TRANSITION

Spencer G. Lucas

New Mexico Museum of Natural History and Science, 1801 Mountain Road N. W., Albuquerque, New Mexico 87104 USA; e-mail: spencer.lucas[at] state.nm.us

In May, the New Mexico Museum of Natural History and Science hosted an international scientific meeting on the Carboniferous-Permian transition in Albuquerque, New Mexico. The meeting organizing committee consisted of Spencer G. Lucas (NMMNHS, Albuquerque), James E. Barrick (Texas Tech University, Lubbock), Vladimir Davydov (Idaho State University, Boise), William DiMichele (Smithsonian Institution, Washington, D. C.), Karl Krainer (University of Innsbruck, Austria), John Nelson (Illinois Geological Survey, Champaign), Jörg W. Schneider (Bergakademie Freiberg, Germany) and Sebastian Voigt (Urweltmuseum, Thallichtenberg, Germany). The meeting was also an official joint meeting of the Subcommission on Carboniferous Stratigraphy (SCS) and of the Subcommission on Permian Stratigraphy (SPS).

Approximately 80 scientists from 11 countries (Brazil, Canada, China, Czech Republic, Germany, Italy, The Netherlands, Russia, The United Kingdom, Uruguay and the USA) participated in the meeting. The meeting consisted of three days of talks and poster presentations at the Museum in Albuquerque (May 20-22).

Participants in the Carboniferous-Permian Transition meeting examine Upper Pennsylvanian strata and fossils at the Kinney Brick Quarry in central New Mexico, May 2013.

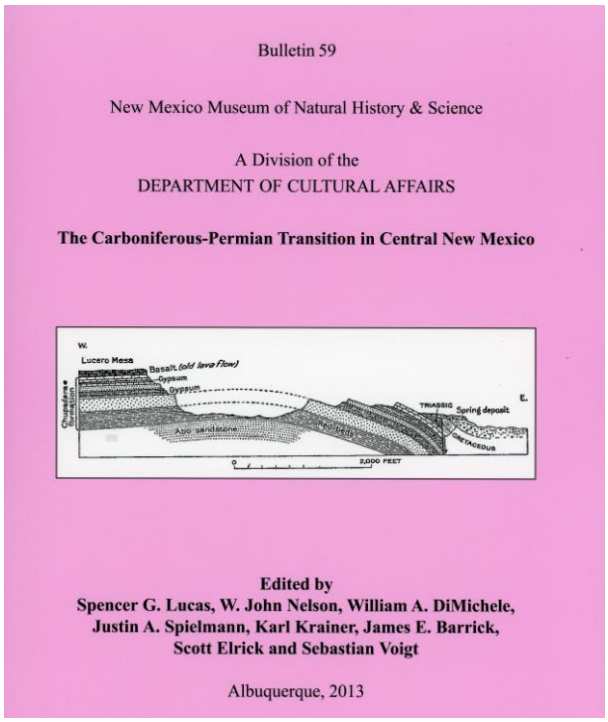
The talks began with summaries of the current status of the Carboniferous timescale (by SCS Chairman Barry Richards) and of the Permian timescale (by SPS Chairman Shuzhong Shen).

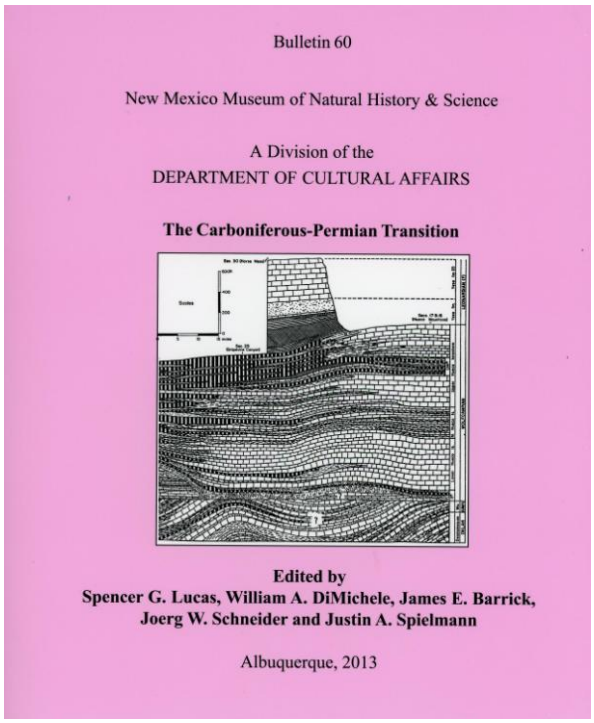
Additional talks on issues of correlation and timescale were followed by sessions devoted to Carboniferous-Permian environments, particularly the Late Paleozoic ice ages. A strong paleobotanical presence at the meeting was reflected by sessions on fossil plants that ranged from taxonomy to morphology to issues of distribution in time, space and environments.

Before the meeting, there was a one day fieldtrip to the world famous Carboniferous-Permian boundary section at Carrizo Arroyo. This section, of the Bursum Formation, features intercalated marine and nonmarine strata with marine biostratigraphic control, based on conodonts and fusulinids, and nonmarine Lagerstätten dominated by fossil plants and arthropods. During the meeting, the famous Late Pennsylvanian fossil locality at the Kinney Brick Quarry just east of Albuquerque was visited (see photo). And, after the meeting, a three-day fieldtrip examined the Carboniferous-Permian rocks and fossil sites east of Socorro in central New Mexico. These strata are a complex mix of marine and nonmarine rocks deposited during the Ancestral Rocky Mountain orogeny.

The generous support of the New Mexico Museum of Natural History Foundation, the Kinney Brick Company, the U. S. Bureau of Land Management and the New Mexico Bureau of Geology and Mineral Resources contributed to the success of the meeting.

Proceedings of the meeting and a field guide have been published by the New Mexico Museum of Natural History and Science as Bulletins 59 and 60. The pdfs from these volumes will soon be available for free download on the SCS and SPS websites.





ANNUAL REPORT FOR NOVEMBER 1ST, 2012 TO OCTOBER 31ST, 2013

This version of the SCCS annual report is abbreviated from the document submitted by our chairman to the ICS. The complete annual report for 2013 will be posted on our new website at http://www.stratigraphy.org/carboniferous/.

OVERALL OBJECTIVES, AND FIT WITHIN IUGS SCIENCE POLICY

The SCCS promotes and coordinates international cooperation among various geologic specialists for the purpose of defining standard Global chronostratigraphic boundaries within the Carboniferous System. The GSSP for the Devonian-Carboniferous boundary is at La Serre in southern France (Paproth & Streel, 1984; Paproth *et al.*, 1991), and the Carboniferous-Permian boundary GSSP has been selected in northern Kazakhstan (Davydov *et al.*, 1998). The Mid-Carboniferous boundary GSSP is preserved in Arrow Canyon, Nevada, U.S.A. (Lane *et al.,* 1999; Richards *et al.*, 2002), and it subdivides the Carboniferous into two subsystems, the Mississippian Subsystem below and the Pennsylvanian Subsystem above. The immediate SCCS goals are to redefine the Carboniferous-

Devonian boundary and select the best stage boundaries within the two Carboniferous subsystems to facilitate global correlation within the system.

CHIEF ACCOMPLISHMENTS AND PRODUCTS IN NOVEMBER 1ST 2012 - OCTOBER 31ST 2013 FISCAL YEAR

Task Group Progress Reports

Only the highlights of the task-group reports are provided in this summary. The full task-group reports, including membership, are included in web version of the Annual Report and in this volume of the newsletter under Task-Group Reports for Nov. 1st, 2012 to Oct. 31st, 2013 Fiscal Year.

Task group to redefine the Devonian-Carboniferous Boundary [which is also the base of the Lower Mississippian Series and Tournaisian Stage] was established in early 2008 and is chaired by Markus Aretz (France; markus.aretz[at]get.obs-mip.fr).

During the fiscal year, the group continued with it primary tasks – the search for a suitable criterion for redefinition of the D-C boundary and the hunt for a suitable section for the GSSP. Studies by Ji *et al*. (1989) and subsequent analysis (Kaiser, 2009) demonstrated severe problems exist with the D-C boundary GSSP (Paproth *et al*., 1991) at La Serre Hill, France. The boundary at La Serre is currently defined by the first occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *Siphonodella praesulcata* Sandberg, 1972 to *S. sulcata.*

During the 2013 fiscal year, the working-group's most important conference activity was attending the SDS/SCCS workshop at Erfoud, Morocco (March 22nd to 29th, 2013) (Becker *et al*., 2013).

Researchers at Erfoud agreed on several points that should provide guidelines for further activities and discussions:

a. All potential criteria for the D-C boundary definition require study. The new boundary definition does not need to be a conodont.

b. A multidisciplinary approach should be used for boundary definition. The presence or absence of a single criterion cannot be the only argument for placing the boundary.

c. If the boundary level has to be changed, it should not be raised into the Tournaisian.

d. The major late Famennian extinction (Hangenberg Event) is a good potential candidate for a new definition of the boundary, but additional detailed stratigraphic data are required before it can be used.

In a final discussion, task-group members agreed that a principal goal for the 2013-2014 fiscal years is the compilation of detailed data sets for the best boundary sections throughout the world.

Task Group to establish the Tournaisian-Viséan Boundary which is also the base of the Middle Mississippian Series] is chaired by George Sevastopulo (Ireland; gsvstpul[at]tcd.ie).

Following approval of the proposed GSSP (Devuyst *et al.,* 2003) at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst had been preparing the final report about the Tournaisian-Viséan boundary GSSP but the task-group chairman George Sevastopulo has taken over that role.

Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series] is chaired by Barry Richards (Canada; barry.richards[at]NRCan.gc.ca).

An index for boundary definition has been selected, but not voted on by the task group and SCCS for final approval, and work is well advanced at the two prime GSSP candidate sections: the Verkhnyaya Kardailovka in the southern Ural Mountains of Russia (Nikolaeva *et al*., 2002, 2009; Nikolaeva, 2013) and the Naqing (Nashui) section in southern Guizhou Province, China. For boundary definition, the group is using the first evolutionary appearance of the conodont *Lochriea ziegleri* Nemirovskaya, Perret & Meischner, 1994 in the lineage *Lochriea nodosa* (Bischoff, 1957) –*Lochriea ziegleri. L. ziegleri* appears in the Brigantian Substage of NW Europe somewhat below the current base of the Serpukhovian as defined by its lectostratotype section in the Zaborie quarry near the city of Serpukhov in the Moscow Basin, Russia (Kabanov *et al*., 2009, 2012, 2013).

The most important accomplishments in 2013 were: 1) the publication of a comprehensive study of the conodonts spanning the Viséan-Serpukhovian boundary in the Naqing section in South China (Qi *et al*. 2013), 2) the publication of a paper about the degree of diachroneity at the proposed base of the Serpukhovian in NW Europe as defined by the first appearance of *L. ziegleri* and correlating that FAD with the ammonoid zones (Sevastopulo & Barham, 2013), and 3) the completion of a sedimentologic-biostratigraphic (ammonites and conodonts) study across the boundary level in the Verkhnyaya Kardailovka section (Richards *et al*., in press).

Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series] is chaired by Alexander Alekseev (Moscow State University, Russia; aaleks[at]geol.msu.ru).

Although more than 10 conodont and fusulinid taxa have been proposed as potential markers for

the GSSP over the last several years, only two conodont species (*Declinognathodus donetzianus* Nemirovskaya, 1990 and *Diplognathodus ellesmerensis* Bender, 1980) are currently considered to have substantial potential for definition of a boundary position close to the original base of the type Moscovian. Several candidate sections for the GSSP are being studied but the Naqing section in southern Guizhou province of South China appears to have the best potential (Qi *et al*., 2010). The Basu River section (Kulagina *et al*., 2009) in the southern Urals of Russia is undergoing intensive study in preparation for the a field trip for XVIII International Congress on Carboniferous and Permian that will be held in Kazan, Russia on August 7-15, 2015.

Task group to establish the Moscovian–Kasimovian [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian – Gzhelian boundaries** is chaired by Katsumi Ueno (Japan; katsumi[at]fukuoka-u.ac.jp).

In the past fiscal year, the task-group members continued to study the Moscovian-Kasimovian and Kasimovian-Gzhelian stage boundaries in their respective areas. The search continued for an index within an evolutionary lineage for definition of the base of the Kasimovian. Conodont-based proposal have been made for that boundary and are being tested prior to final approval. The first appearance datum (FAD) of a conodont has been formally selected for defining the base of the Gzhelian Stage and the search for a suitable section for the GSSP continues.

Moscovian-Kasimovian Boundary

As potential marker events for defining the base of the Kasimovian Stage, Villa & the task group (2008) proposed using the FADs of the conodont *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009a. Their occurrence (near base of Khamovnikian Substage, the second substage of the Kasimovian in current definition) is approximately one substage higher than the traditional base of the Kasimovian (base of Krevyakinian Substage). A new option is to use the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013. Until now, however, no formal proposal for a marker species to define the base of the Kasimovian Stage has been presented. In the last few years, task-group members have been working on sections in North America, South China and Eurasia in order to understand the phylogeny, systematics and distribution of these potential indices.

Kasimovian-Gzhelian Boundary

After fixing the base of the Gzhelian Stage by using the first appearance datum of the conodont *Idiognathodus simulator* (Ellison, 1941) *s.s.* in its potential lineage *Idiognathodus eudoraensis* - *I. simulator* (Heckel *et al*., 2008; Villa *et al*., 2009), the task group is directing research toward selecting a suitable section for the GSSP.

Gusal Sungatullina (Kazan University, Russia) is restudying the conodonts across the boundary within the Usolka section in the southern Ural Mountains of the Russian Federation. Alexander Alekseev is strongly expecting the results of Gusal's study to be sufficient to propose using the Usolka section as a potential GSSP candidate for the base of the Gzhelian.

Qi Yuping & James Barrick continue investigation of the Naqing (Nashui) section in southern Guizhou province and consider it to have promise as a potential GSSP candidate, however, there is a conodont-poor gap of about 2 m below the first occurrence of *I. simulator* in that section.

The North America Midcontinent sections also possess a gap in the *Idiognathodus* succession below the first occurrence of *I. simulator* in the Heebner Shale (Oread cyclothem). *Idiognathodus simulator* was originally described from the Oread cyclothem. Nick Hogancamp (Texas Tech University) has started a detailed study of the *I. simulator* morphotypes in the Oread cyclothem and reports that at least three major morphotypes are present in these collections.

James Barrick suggested that because of the strongly cyclical nature of most upper Kasimovian to lower Gzhelian sections in the North America Midcontinent region and the lack of a well-documented species transition leading to *I. simulator*, prospects look poor for establishment of a typical GSSP in that region based on the FAD of a species. The working group may consider proposing that the definition for the base of the Gzhelian is the eustatic event during which *I. simulator* appears. In this instance, the eustatic event would be the primary criterion and the FOD of *I. simulator* becomes the biostratigraphic marker by which the eustatic event can be globally identified and correlated.

The Project Group on Carboniferous Magnetostratigraphy, chaired by Mark Hounslow (United Kingdom; m.hounslow[at]lancaster.ac.uk), which did not submit a progress report this year for the Newsletter on Carboniferous Stratigraphy, summarized the recent work of the group through June 2009 in volume 27 of the Newsletter on Carboniferous Stratigraphy.

Conferences and field meetings November 1st, 2012 - October 31st, 2013

The two most significant meeting were the joint SDS/SCCS workshop – The Devonian and Lower

Carboniferous of northern Gondwana at Erfoud in Morocco (March 22nd to 29th, 2013) and The Carboniferous-Permian Transition (May 19th to 25th, 2013) a joint conference and field meeting of the SCCS and SPS held in Albuquerque, New Mexico, USA (Lucas *et al*., 2013).

The Morocco meeting included one main day of oral and poster presentations and six days of field trips in the eastern Anti-Atlas Mountains of Morocco. Several members of the task group to redefine the D-C boundary and members from other task groups presented the results of recent work and their abstracts were published in the Abstract volume for the conference (El Hassani *et al*., 2013). An important field guidebook presenting substantial information about the Devonian-Carboniferous boundary interval and overlying Tournaisian to Viséan deposits in the Anti-Atlas Mountains Morocco was published (Becker *et al*. (eds.) 2013).

The Carboniferous-Permian Transition meeting in New Mexico included two and a half days of oral and poster presentations in Albuquerque and 4.5 days of field trips in the Albuquerque and Socorro regions of New Mexico. The field guides were published in one of the two proceedings volumes along with several stratigraphic papers about the Carboniferous and Permian of New Mexico (Lucas *et al*., 2013a). Members of several task groups along with corresponding members presented the results of their recent work and their abstracts along with the associated manuscripts were published in the two proceedings volumes for the conference (Lucas *et al*., eds., 2013b).

Output

The **Newsletter on Carboniferous Stratigraphy, Volume 30**, published in February, 2013 and available for download from our website, includes commentaries by the current SCCS executive on various current issues, summaries about field meetings and workshops, reports of the task groups for November 1st 2011 to October 31st 2012, and articles on various topics of subcommission interest. The Newsletter provides a significant outlet for timely presentation and discussion of useful information relating to boundary selection, often from areas that are not typically covered in other journal venues. During the last fiscal year, task-group and corresponding members published a number of papers in refereed journals and in abstract volumes associated with conventions. Many of the most important of these publications are cited in the progress reports included in the full version of the Annual Report posted on our website.

Important outputs during the year were:

BECKER, T., EL HASSANI, A., & A. TAHIRI (eds.) (2013): International field symposium "The Devonian and Lower Carboniferous of northern Gondwana. — *Field Guidebook, Document de l'Institute Scientifique, Rabat*, **27**, 2013, 150 p.

EL HASSANI, A., BECKER, T. & A. TAHIRI (eds.) (2013): International field symposium "The Devonian and Lower Carboniferous of northern Gondwana. — *Document de l'Institute Scientifique, Rabat*, **26**, 2013, 134 p.

LUCAS, S.G., NELSON, J.W., DIMICHELE, W.A., SPIELMANN, J.A., KRAINER, K., BARRICK, J.E., ELRICK, S. & S. VOIGT (eds.) (2013a): The Carboniferous-Permian transition in central New Mexico. — *New Mexico Museum of Natural History and Science*, *Bulletin,* **59**, 389 p.

LUCAS, S.G., NELSON, J.W., DIMICHELE, W.A., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.) (2013b): The Carboniferous-Permian transition. — *New Mexico Museum of Natural History and Science*, *Bulletin*, **60**, 465 p.

Website

During the Nov. 1st, 2012 to Oct. 31st 2013 fiscal year, the SCCS revised its official website http://www.stratigraphy.org/carboniferous/.

Chief problems encountered in 2013

Several ongoing problems confronted the SCCS task groups during the fiscal year but the most significant issue confronting the SCCS has been the difficult and time-consuming task of locating suitable evolutionary lineages and first occurrences for boundary definition. Within the Carboniferous, the endemism of conodont, foraminiferal, and ammonoid lineages between Eurasia and North America continues to hamper the choice of the boundary levels for the Viséan-Serpukhovian and Bashkirian-Moscovian boundaries. Progress by the project group on Carboniferous magnetostratigraphy has been hampered by a shortage of members, insufficient funding, and a lack of integration with the activities of the other task groups.

WORK PLANS, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2014):

The following activities are planned for the Nov. 1st, 2013 to Oct 31st, 2014 fiscal year by the task groups, as communicated by task-group chairs and distilled from the task-group progress reports.

Our principal mandate

The establishment of GSSPs for the Carboniferous and its main subdivisions is our principle mandate from the ICS. During the current four-year term, the ICS executive wants to have the SCCS establish GSSPs for as many of the Carboniferous Stage boundaries as possible. At

present, GSSPs need to be established for the Viséan-Serpukhovian, Bashkirian-Moscovian, Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries. In addition, the GSSP at the base of the Tournaisian has been reassessed and both a new marker event and a new section will probably be required for that boundary. Based on the information our task-group leaders have provided us in the last two issues of the SCCS annual report to the International Commission of Stratigraphy and volume 30 of the Newsletter on Carboniferous Stratigraphy, we are confident that during the next four years GSSPs can be established for most of the boundaries.

Within the next two years, we think it will be possible to select the boundary defining events for all of the stage boundaries with the exception of the base of the Tournaisian and then direct full effort toward selecting sections for the GSSPs. At present, most SCCS task groups have either selected an event to define their respective boundary and held a successful vote on it (Kasimovian-Gzhelian task group) or have located an event and are preparing proposals in preparation for taking the proposal to ballot.

Task group work plans

Devonian-Carboniferous boundary Primary tasks for the D-C boundary task group are to locate a suitable event marker to define the boundary and find a suitable section for the GSSP. To help achieve these goals, work in 2014 will focus on the compilation of detailed data sets for the best boundary sections throughout the world. Data to be integrated will be derived from the evaluation of lithology and facies, distribution of fauna and flora, and geochemical and geophysical data.

Considerable progress on re-evaluating all of the conodonts within the D-C boundary interval including the current D-C boundary marker, the FAD of the conodont *S. sulcata,* has been made (Corradini *et al*., 2013). Additional study of the conodonts is required, however, and the task group plans to complete that work shortly. Several task-group members have been studying the taxonomic and phylogenetic problems within the protognathodid conodont lineages (Corradini *et al*., 2011; Corradini *et al*., 2013). Four species of *Protognathodus* are known from the relevant time span: *Protognathodus meischneri, P. collinsoni, P. kockeli* and *P. kuehni.* Presently favoured for boundary definition are the first occurrences of *P. kockeli* from *P. collinsoni* and *P. kuehni* from *P. kockeli.* The SCCS executive has asked the conodont specialists to evaluate the utility of using the lineages for boundary definition by studying them in the best of their D-C boundary sections.

It has been proposed that the task group consider using some component of the multiphase Hangenberg Event Interval (Kaiser *et al*., 2008) for boundary definition. Markus Aretz asked members to prepare for the D-C boundary workshop in Erfoud Morocco (March 22nd to 29th, 2013) by developing precise correlation charts for the best D-C boundary sections in their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg Event interval. The data sets had not been completed for the meeting and Markus Aretz is requesting the work be completed during 2014.

Tournaisian-Viséan boundary The task group plans to continue with preparation of the final manuscript for the project. George Sevastopulo, the task group chairman, is leading that work.

Viséan-Serpukhovian boundary The task group has determined that the FAD of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa–Lochriea ziegleri* is the best index for boundary definition and plans to draft a proposal advocating the use of that index. During the 2014 fiscal year, the team will continue to direct its attention toward selecting the best candidate section for the GSSP. The best two candidate sections are the Naqing (Nashui) section by the village of Naqing in southern Guizhou Province, China and the Verkhnyaya Kardailovka section on the Ural River in southern Russia.

Bashkirian-Moscovian boundary The task group plans to continue evaluating conodont lineages suitable for definition of the Bashkirian-Moscovian boundary and it is anticipated that during the 2014 and 2015 fiscal years a lineage and taxon suitable for boundary definition will be selected. The group also plans to continue its search for suitable GSSP candidate sections particularly in South China, southern Urals, and the Donets Basin.

A major effort will be devoted to the continued study of the conodonts within the Bashkirian-Moscovian transitional interval in the Naqing (Nashui) section and nearby sections in southern Guizhou Province, South China. Special attention will be directed toward the study of the lineage containing *Diplognathodus ellesmerensis* Bender 1980, one of the taxa considered to have the best potential for boundary definition. Qi Yuping, Tamara Nemyrovska, & Lance Lambert are going to do the detailed taxonomy work on the conodonts from the Bashkirian-Moscovian boundary interval in the Naqing section.

The task group also plans to continue with its evaluation of the FAD of *Neognathodus bothrops* Merrill 1972, another conodont considered to have potential for boundary definition (Alekseev & Goreva, 2013). Unfortunately, the use of *N. bothrops*

will necessitate moving the base of the Moscovian up one substage from the base of the Vereian regional Substage of Russia (lowermost Moscovian substage) to the base of Kashirian regional Substage of Russia.

Moscovian-Kasimovian boundary During the 2014 fiscal year, the search will continue for a suitable index within an evolutionary lineage for definition of the base of the Kasimovian. The ongoing biostratigraphic analyses reported on in section 3a above will continue. Until the 2013 fiscal year, the task group had concluded the first appearance datums (FADs) of either *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009 had good potential as a marker for the base of the Kasimovian (Villa & task group, 2008; Ueno & task group, 2011). Unfortunately, the use of either species would raise the base of the Kasimovian up approximately one substage from the traditional position at the base of the Russian Krevyakinian Substage. Now, a slightly lower level defined by the occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus* is newly proposed as a more appropriate position of the potential base of the Kasimovian. Thus the task- group members are encouraged to expand their target for detailed examination to a slightly wider stratigraphic interval (approximately Krevyakinian-lower Khamovnikian) for the relevant boundary investigation.

Kasimovian-Gzhelian boundary Since 2007, when the task group voted in favor of using the first appearance of the conodont *Idiognathodus simulator* (Ellison, 1941) in the lineage *Idiognathodus eudoraensis* - *I. simulator* as the boundary-defining event (Heckel *et al*., 2008), the search for a suitable section for the GSSP has been the task-group's main objective. The event level is consistent with both the working ammonoid definition of the boundary and with the first appearance of a cotype of the fusulinid *Rauserites rossicus* in the Moscow region.

Only the Usolka section in the southern Ural Mountains of Russia has been proposed as a candidate section for the GSSP at the base of the Gzhelian (Chernykh *et al.,* 2006; Davydov *et al*., 2008). Gusal Sungatullina (Kazan University) will continue to investigate the conodonts from Usolka and Alexander Alekseev is anticipates her results will permit the Usolka section to be considered as a GSSP candidate for the base of the Gzhelian.

Yuping Qi & colleagues will continue their intensive investigation across the proposed Kasimovian-Gzhelian boundary level in the Naqing section (Wang & Qi, 2003) in Guizhou Province, south China but will continue to investigate other sections in the region as well.

Work plans B

Meeting-field workshop schedule

During the November 1st, 2013 - October 31st, 2014 fiscal year, the most important SCCS meeting will be a joint one with the Subcommission on Permian Stratigraphy (SPS) – **Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation** from the 21 – 27 of July 2014 in Freiberg, Germany. There will be several Russian field meetings in preparation for the **XIVIII International Congress on the Carboniferous and Permian (ICCP)**, which will be held in Kazan, Russia in the summer of 2015. All of the SCCS task groups will be holding workshops and business meetings at the ICCP, our most important quadrennial meeting. This summer, a major focus for most task-groups will be the completion of field work in Russia in preparation for the conference field-trip guides and technical-session presentations.

SUMMARY OF EXPENDITURES IN 2013

Statement of operating accounts for November 1st, 2012 to October 31st, 2013

Prepared by Barry Richards, Chairman SCCS

(Accounts maintained in Canadian currency)

INCOME (November 1, 2012 – October 31, 2013)

IUGS-ICS Grant; July 14, 201 (US $1,800 = $1,679.40 Cdn.)	$0.00
Donations from Members; November 1, 2012 - October 31 2013	$0.00
Interest Bank of Montreal; November 1, 2012 - October 31, 2013	$0.00
TOTAL INCOME	**$0.00**

EXPENDITURES (November 1, 2012 – October 31, 2013)

Bank Charges: Bank of Montreal	$0.00
Travel and conference registration support for SCCS voting members and executive to attend and give oral presentations (no requests)	$0.00
TOTAL EXPENDITURE	**$0.00**

BALANCE SHEET (2012 – 2013)

Funds carried forward from October 31, 2012	$706.62
Plus Income November 1, 2012 – October 31, 2013	$0.00
Total assets	**$706.62**
Less Expenditures November 1, 2012 – October 31, 2013	0.00
BALANCE CARRIED FORWARD (to 2013 – 2014 fiscal year)	**$706.62**

BUDGET AND ICS COMPONENT FOR Nov. 1, 2013 - Oct. 31, 2014 fiscal year

PROJECTED EXPENSES	
Travel support for voting members to participate in summer field meetings in Russia in preparation for XIVIII ICCP	$1000.00
TOTAL PROJECTED EXPENSES	**$1,000.00**
INCOME	
Carryover (from CREDIT balance at end Nov. 1, 2012 - Oct. 31 2013 fiscal year)	$706.62
Estimated donation	$200.00
TOTAL PROJECTED EXPENSES	**$1906.62**
BALANCE	
Estimated (deficit) / credit from above	$906.62
BUDGET REQUEST FROM ICS for 2014	$1,000.00

APPENDIX A

SUMMARY OF CHIEF ACCOMPLISHMENTS OVER PAST FIVE YEARS (2009-2013)

Background: A vote by the ICS in late 1999 resulted in approval of the names Mississippian and Pennsylvanian along with a reconfirmation of the previous decisions of the SCCS to regard their rank as subsystems. In 2003 the SCCS voted to classify the two subsystems into Lower, Middle, and Upper Mississippian Series and Lower, Middle, and Upper Pennsylvanian Series, by a 74% majority of those 90% of the total membership who voted. This vote with its implicit acceptance of the stage names used in Russia as the global stage names for the Carboniferous provides the Carboniferous with its official global series and stage names (Heckel & Clayton, 2006a, 2006b).

Task Group to redefine the Devonian-Carboniferous Boundary

Studies by Ji *et al*. (1989) and subsequent analysis (Kaiser, 2009) demonstrated severe problems exist with the Devonian-Carboniferous Boundary GSSP (Paproth *et al*., 1991) at La Serre Hill, France. These problems resulted in establishment of the joint Devonian-Carboniferous Boundary GSSP reappraisal task group in 2008.

Following a 2008 SCCS workshop at the 33rd International Geological Congress (IGC) in Oslo, Richards included plans for future work by the task group in the 2008 SCCS Annual Report submitted to the ICS. The plan had three recommendations: 1) the use of the first evolutionary occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *S. praesulcata* Sandberg, 1972 to *S. sulcata* for boundary definition requires re-evaluation; 2) if the FAD of *S. sulcata* is retained for boundary definition, either the position of the GSSP at La Serre must be lowered from the base of bed 89 or a more suitable section must be located, and 3) because the first appearance of *S. sulcata* may not be the best marker, other conodont lineages require evaluation.

Progress

Since 2008 the *S. praesulcata* to *S. sulcata* conodont lineage used to define the boundary has been re-evaluated by several scientists including Kaiser & Corradini (2011), and the protognathodids, the other conodont group that had shown potential for boundary definition is being re-studied (Corradini *et al*. 2011; Corradini et al., 2013). It appears that neither the siphonodellid lineage nor the protognathodids are suitable for D-C boundary definition and other appropriate taxa have not been discovered. However, there is considerable disagreement among the conodont specialists about the utility of the siphonodellid lineage and the conclusions of Kaiser & Corradini (2011) require testing by other specialists before the FAD of *S. sulcata* is abandoned for boundary definition.

During the 2010 IPC3 workshop in London, the multi-phase Hangenberg Event (Kaiser, 2005; Kaiser *et al*., 2008) was identified as a level of interest for boundary definition. To obtain a better understanding of the Hangenberg and its utility for boundary definition, group members embarked on multi-disciplinary investigations aimed at understanding the event and presented preliminary results at the joint SDS/SCCS meeting held in Morocco in March 2013.

From the work completed from 2009 through 2013, it is clear that the La Serre section is not suitable for the GSSP. A major issue is the base of bed 84b, which contains the FAD of *S. sulcata* is a sharp facies change Kaiser (2009) and probably erosional; in addition, underlying strata lack the evolutionary lineage from *S. praesulcata* to *S. sulcata*. New D-C boundary sections are being evaluated and previously studied sections are being re-evaluated.

Tournaisian-Viséan Boundary By 2003 work by the Tournaisian-Viséan Boundary task group progressed to the point that a proposal for the GSSP in south China was published (Devuyst *et al,* 2003), unanimously approved by the SCCS, and ratified by the ICS and IUGS. The Secretary's report for 2008 (Newsletter on Carboniferous Stratigraphy, v. 26 p. 4) provides the details about the proposal and SCCS ballot. The principal work of the task group has come to completion and task-group Chairman George Sevastopulo is preparing the final report.

Viséan-Serpukhovian Boundary The Viséan-Serpukhovian Boundary task group plans to use the FAD of *Lochriea ziegleri* Nemirovskaya, Perret &

Meischner 1994 in the conodont lineage, *Lochriea nodosa* (Bischoff, 1957) -*Lochriea ziegleri,* for boundary definition. By 2010 the *L. nodosa-L. ziegleri* lineage had become widely recognized in Western Europe, Russia and Asia (Skompski *et al*., 1995; Nikolaeva *et al*., 2009; Qi *et al*., 2013) and although the lineage is not yet known from North America, specimens of *L. ziegleri* and other species in the genus have been discovered. By late 2010, the task group decided the FAD of *L. ziegleri was* suitable for boundary definition and a proposal is being written in preparation for a vote by the task group and SCCS.

The identification of the *Lochriea* lineage along with recognition of the conodont, ammonoid, ostracode, and foraminiferal zones in a deep-water (basinal), carbonate section by the village of Verkhnyaya Kardailovka on the eastern slope of the Russian Urals established that section as a strong candidate for a GSSP (Nikolaeva *et al*., 2005). Since 2005 the section has been thoroughly examined and syntheses published about the ammonoids, conodonts, and ostracodes (Nikolaeva *et al*., 2009; Pazukhin *et al*., 2010; Nikolaeva, 2013). The synthesis indicates conodonts that are transitional between *L. nodosa* and *L. ziegleri* occur in the section immediately below the FAD of *L. ziegleri.*

In 2005 the *Lochriea* lineage was reported from carbonate-slope facies in the Naqing (Nashui) section in southern Guizhou Province, China (Qi & Wang, 2005). Since 2007, the conodonts spanning the Viséan-Serpukhovian boundary in the Nashui section have undergone intensive study by Chinese colleagues and the section has become a strong potential candidate for a GSSP at the base of the Serpukhovian. Qi Yuping has finished his analysis of the conodonts across the Viséan-Serpukhovian boundary at Nashui (Qi *et al.*, 2013) and incorporated the results in his doctoral thesis and subsequent papers (Qi, 2008). In the Nashui section, conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant. Bed-by-bed sampling for sedimentologic and geochemical analyses has been completed across the Viséan-Serpukhovian and Serpukhovian-Bashkirian boundaries and the samples are being processed. John Groves completed his study of the foraminifers and that study (Groves *et al*., 2012) indicates foraminifers can be used to bracket the level of the FAD of *L. ziegleri* thereby facilitating correlations into shallow-water carbonate sections lacking diagnostic conodonts. The measurement and intensive study of several other sections in the region from 2009 through 2013 is enabling the task group to place the Nashui section into its paleogeographic, stratigraphic, and lithofacies contexts.

In June 2010, Spanish colleagues introduced task-group members to several sections spanning the Viséan-Serpukhovian boundary in the Cantabrian Mountains of Spain. Two of the sections, the Vegas de Sotres and Millaró (Sanz-López *et al*. 2007) in the Alba Formation, are excellent deep-water carbonate sections rivaling the better known Kardailovka and Nashui exposures. In the Vegas de Sotres and Millaró sections, conodonts within the *L. nodosa* - *L. ziegleri* lineage are well preserved and abundant; in addition, the first occurrence of *L. ziegleri* has been located with moderate precision. A major biostratigraphic advantage of the two sections is the common occurrence of abundant, well-preserved ammonoids that are being studied by Svetlana Nikolaeva. The conodont biostratigraphy has been relatively well established in the two sections (Sanz-López *et al*., 2007; Blanco-Ferrera *et al*., 2009).

Work has been initiated on ammonoid-rich successions in the western U.S.A. (Korn & Titus, 2011), southern Urals and Kazakhstan, and on foraminifer- and coral-rich successions in Western Europe and western Canada in order to bracket the level of the first appearance of *L. ziegleri* in North America. By the end of the 2013 fiscal year, the lineage had not been identified in North America but *L. ziegleri* has been found in the Barnett Shale in Texas and other species of *Lochriea* have been identified at several localities (Brenckle *et al*., 2005; Qi Yuping, pers. com., 2010).

Bashkirian-Moscovian Boundary More than 10 conodont and foraminiferal lineages have been appraised and potential candidate sections located but a marker for the Bashkirian-Moscovian Boundary has not been selected and voted on. At present, the conodonts *Diplognathodus ellesmerensis* Bender, 1980 and *Declinognathodus donetzianus* Nemirovskaya, 1990 are considered to have the best potential for boundary definition. Another potential index for the boundary is the FAD of the conodont *Neognathodus bothrops* Merrill, 1972.

Substantial work has gone into evaluating the *Declinognathodus marginonodosus—D. donetzianus* lineage for boundary definition but the lineage appears to lack a sufficiently wide geographic distribution. Other conodont taxa and fusulinids are being used for correlations into successions where the latter lineage has not been located. For example, members reported the appearance of the distinctive *Profusulinella prisca* fusulinid group near this boundary level in Spain, Turkey, southern Urals, and possibly North and South America. Most recently (2010-2011), the group developed a proposal to use the (FAD) of the fusulinoidean genus *Eofusulina* Rauser-Chernousova in Rauser-Chernousova *et al.* 1951in evolutionary continuity with its ancestor for boundary definition (Groves *et al*., 2011).

Russian colleagues discovered an evolutionary lineage of *Declinognathodus marginonodosus—D. donetzianus* in the Basu River section in the southern Urals, which also contains rich foraminiferal faunas, and might be a candidate for a GSSP. The well exposed Basu section contains the first appearance of the fusulinid *Profusulinella prisca* a few metres below that of *D. donetzianus*. The discovery of the *Declinognathodus* lineage at the Basu River section along with a rich fusulinid fauna including the *P. prisca* group make it a good potential candidate section for a GSSP (Kulagina *et al*., 2009).

In the Naqing (Nashui) section south China, Qi *et al.* (2007) reported the appearance with *D. donetzianus* of another conodont, *Diplognathodus ellesmerensis*, which has a broader more global distribution and would help identify the level of *D. donetzianus* in places where it is absent. The Bashkirian-Moscovian Boundary interval at Naqing has been selected for intensive biostratigraphic and sedimentologic study as a potential candidate for a GSSP. In 2008 John Groves and colleagues visited the carbonate-dominant section and initiated a detailed biostratigraphic and sedimentologic analysis across the boundary. Since that trip, Qi Yuping finished his analysis of the conodonts across the Bashkirian-Moscovian Boundary and incorporated the results in his doctoral thesis (Qi, 2008). A detailed stratigraphic section extending from the upper Serpukhovian into the Moscovian was measured at Nashui and aluminum marker pins placed at one-meter intervals. Groves (2010) completed his study of the foraminifers in the Nashui section and presented the findings at the November 2010 SCCS workshop in Nanjing. The provisional Bashkirian-Moscovian boundary recognized by Qi *et al*. (2007) on the lowest occurrence of *Diplognathodus ellesmerensis* falls 173 m above the base of the section, a level containing a foraminiferal association dominated by *Profusulinella* spp. and *Pseudostaffella* spp.

Goreva & Alekseev (2012) proposed moving the base of the Moscovian one substage higher than the position discussed above; that is from the base of the Vereian regional Substage of Russia (lowermost Moscovian substage) to the base of Kashirian regional Substage of Russia. A proposed marker for the new level is the FAD of *Neognathodus bothrops* Merrill, 1972 from its ancestor *Neognathodus atokaensis* Grayson, 1984. Both species occur in the Midcontinent region of the U.S.A., Moscow Basin and South Urals of Russia, and the Donets Basin in Ukraine.

Moscovian-Kasimovian Boundary The Moscovian-Kasimovian task group has extensively evaluated conodonts and fusulinoideans as indices for definition of the base of the Kasimovian and has concluded that conodonts present the best potential. The first appearance datums (FADs) of *Idiognathodus sagittalis* Kozitskaya, 1978 and *Idiognathodus turbatus* Rosscoe & Barrick, 2009a have good potential as markers for the base of the Kasimovian (Ueno & task group, 2011). Their occurrence (near base of Khamovnikian regional Russian Substage, the second substage of the Kasimovian in current definition) is approximately one substage higher than the traditional base of the Kasimovian (base of Krevyakinian Substage). Now, a slightly lower level defined by the occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus* is newly proposed as a more appropriate position of the potential base of the Kasimovian. Thus the task- group members are encouraged to expand their target for detailed examination to a slightly wider stratigraphic interval (approximately Krevyakinian-lower Khamovnikian) for the relevant boundary investigation.

Fusulinid workers have conceded that problems of provincialism across the boundary interval preclude the use of that group to define the boundary.

Kasimovian-Gzhelian boundary Members of the Kasimovian-Gzhelian_Boundary task group plan to use the FAD of the conodont *Idiognathodus simulator s.s.* (Ellison, 1941) in the lineage *Idiognathodus eudoraensis - I. simulator s.s.* to define the boundary (Heckel *et al.,* 2008; Barrick *et al*., 2008).

The search for a suitable candidate section for the GSSP has started with the investigation of two sections; additional candidates are required. A preliminary description of the potential GSSP at Usolka in the southern Urals was published by Chernykh *et al.* (2006) and in more detail by Davydov *et al.* (2008). Gusal Sungatullina (Kazan University) is investigating the conodonts from Usolka & Alexander Alekseev is anticipates her results will permit the Usolka section to be considered as a GSSP candidate for the base of the Gzhelian.

The other potential candidate section lies within the Naqing (Nashui) section in south China and is undergoing a thorough biostratigraphic, sedimentologic and geochemical investigation. Within the section, the presence of the lineage containing *I. simulator* has been proven. Existing conodont collections from the Kasimovian-Gzhelian Boundary interval at Naqing permit recognition of the boundary but are insufficient to make a complete description of the boundary conodont faunas. Qi & Barrick are working on new and larger collections to obtain a more complete understanding of the fauna and enable a better

evaluation of the section as a GSSP for the base of the Gzhelian.

Project Group on Carboniferous Magnetostratigraphy The magnetostratigraphy project group was formed in 2004 and chaired by Mark Hounslow to research the potential for identifying correlatable magnetostratigraphic events in the Carboniferous. Hounslow (2009) reported on some aspects of this approach in the 2009 issue of the Carboniferous Newsletter. Progress by the magnetostratigraphy project group has been hampered by a shortage of members and lack of integration with the activities of the other SCCS task groups.

During the November 1st 2008 to October 31st 2009 fiscal year, the search for Mississippian sedimentary rocks that are likely to carry a primary magnetisation, to construct a magneto-stratigraphic timescale, focused on two sections in southern Scotland but no analytical results are available yet. Both sections have good potential for recovery of primary magnetisation because they are dominated by siliciclastics and their thermal maturity is low (Hounslow, 2009).

Peter Giles (Geological Survey of Canada-Atlantic) and colleagues have largely completed a useful magnetostratigraphic study of the Brigantian, Pendleian and much of the Arnsbergian substages (upper Viséan and Serpukhovian) in the Maritimes Basin of eastern Canada (Giles et al., in progress). They have correlated the polarity reversal patterns in the Maritimes Basin with published data from the Brigantian to mid-Arnsbergian interval in the central part of the Appalachian Basin in the eastern United States (Di Venere & Opdyke, 1990, 1991).

Radiometric dating Precise radiometric U-Pb zircon dating (CA and ID-TIMS U-Pb methods) now being undertaken by several groups including the Permian Research Group at Boise State University on ash beds from the latest Devonian and Carboniferous successions in several basins has led to the precise dating and correlation of important Carboniferous events and assisted substantially with calibration of the Carboniferous time scale (Menning *et al*., 2006; Davydov *et al*., 2010; 2012). Since ratification of the Tournaisian-Viséan boundary proposal in 2007, task-group chair George Sevastopulo and his students have been attempting to bracket the absolute age of the Tournaisian-Viséan boundary in Europe by using the ID-TIMS U-Pb method of dating zircons from ash bands and plan to continue with that work.

OBJECTIVES AND WORK PLAN FOR NEXT 4 YEARS (2014-2017)

The SCCS executive is encouraging its task groups to maintain progress on researching and selecting defining events for as many stage boundaries as possible in the next four years. Within the next two years, we think it will be possible to select the defining events for all of the stage boundaries with the possible exception of the base of the Tournaisian and then progress toward selecting sections for the GSSPs. Most task groups have either selected an event to define their respective boundary and held a successful vote on it (Kasimovian-Gzhelian task group) or have located an event and are preparing proposals in preparation for taking the proposal to ballot (Viséan-Serpukhovian, and Moscovian-Kasimovian task groups).

Devonian-Carboniferous Boundary

The main four-year goal of the Devonian-Carboniferous Boundary task group is the selection of an event for defining the base of the Carboniferous because the current definition, the FAD of *Siphonodella sulcata* is apparently deficient. The SDS and SCCS held an important joint meeting - *The Devonian and Lower Carboniferous of northern Gondwana* - in Morocco in March, 2013 (http://www.israbat.ac.ma/seminaires.htm) that provided direction for future research. Following selection of the event, suitable candidate sections for the GSSP must be located.

It appears that neither the siphonodellids nor the protognathodids are suitable for D-C boundary definition but evaluation of these groups will continue. There is some hope the siphonodellid lineage can still be used because considerable disagreement exists among conodont specialists about its utility and the conclusions of Kaiser and Corradini require additional testing before the FAD of *S. sulcata* is abandoned.

In the Devonian-Carboniferous Boundary GSSP section at La Serre, seven morphotypes in the transition from *S. praesulcata* to *S. sulcata* have been identified (Corradini & Kaiser, 2009; Kaiser, 2009). Conodonts within the transition are reworked and no correlation exists between the stratigraphic level and individual morphotypes. The task group plans to determine if a correlation exists between the morphotypes and stratigraphic level in other D-C boundary sections, where reworking is not an issue.

Even if the FAD of *S. sulcata* is retained for boundary definition, a suitable section for the GSSP must be located because recent studies at La Serre indicate the lack of the phylogenetic transition from *S. praesulcata* to *S. sulcata* and the base of bed 84b, which contains the FAD of *S. sulcata,* immediately overlies a probable erosion surface and major lithofacies facies change (Corradini & Kaiser, 2009; Kaiser, 2009). Several sections, particularly those in south-central China, which had been proposed as GSSP candidates prior to selection of the La Serre section, will be carefully re-examined. Intensive

biostratigraphic, geochronologic, sedimentologic and geochemical studies will be initiated at all potential GGSP sections.

The siphonodellids and protognathodids may not be as useful for boundary definition as previously thought, but other significant latest Famennian to earliest Tournaisian biostratigraphic events may have potential for boundary definition and an intensive search will be undertaken to locate them. The task group also plans to explore the possibility of using either a sedimentological or geochemical event such as a component of the multiphase Hangenberg extinction event (Kaiser, 2005; Cramer *et al.*, 2008) for boundary definition. The event presents potential for correlation into both shallow and relatively deep-water marine facies; consequently, the task group wants to know how the phases of the Hangenberg are represented in different facies and how well they can be correlated globally. The latter question is being investigated and preliminary results were presented at the joint SDS/SCCS workshop in Morocco in March, 2013.

Tournaisian-Viséan Boundary By 2003 work by the Tournaisian-Viséan Boundary task group progressed to the point that a proposal for the GSSP in south China was published (Devuyst *et al,* 2003). The principal work of the task group has come to completion and the task-group chairman George Sevastopulo is preparing the final report.

Viséan-Serpukhovian Boundary Task Group The Viséan-Serpukhovian task group plans to use the FAD of *Lochriea ziegleri* in the conodont lineage *Lochriea nodosa* - *Lochriea ziegleri* for boundary definition. A proposal for submission to the task group and SSCS membership for a vote on either accepting or rejecting the FAD of *L. ziegleri* for GSSP requires completion. Two well-known sections, Verkhnyaya Kardailovka and Naqing (Nashui) present the best potential for the GSSP, and the ongoing integrated biostratigraphic, sedimentological and geochemical studies of those sections will continue to project completion. Most of the field work has been completed at both localities and the remaining objective is to complete the sample study and compile the final synthesis. Identification of the *L. nodosa-L. ziegleri* lineage and recognition of associated conodont, ammonoid, ostracode, and foraminiferal zones in the richly fossiliferous section near Verkhnyaya Kardailovka in the southern Urals establishes that section as a strong candidate for the GSSP (Nikolaeva *et al*., 2009; Pazukhin *et al*., 2010; Nikolaeva, 2013). In the Nashui section in southern Guizhou Province, China (Qi *et al*., 2013), the *Lochriea* lineage has been intensively studied and the FAD of *L. ziegleri* precisely located. Field work is essentially complete at Naqing and the remaining objective is to complete the analytical work and prepare the final synthesis for publication.

The *Lochriea* lineage has not been found North America but specimens of *Lochriea ziegleri* and other species within the genus have been discovered. In order to identify correlatable faunal zones that can closely bracket the boundary interval on that continent, a Global study of conodonts, ammonoids, foraminifers, and corals across the boundary interval in North America, Europe and Asia will continue. All this suggests selection of the GSSP is possible in the next four years.

Bashkirian-Moscovian Boundary Task Group The high-priority plans for the Bashkirian-Moscovian Boundary task group during the next four years are to select an event marker for the Bashkirian-Moscovian boundary and then to look for GSSP candidate sections. Several conodont lineages require immediate evaluation. Until the fall 2010, much of the task group's time was directed toward the evaluation of two conodont lineages that had moderate potential for boundary definition: 1) derivation of *Idiognathoides postsulcatus* from *Id. Sulcatus*, and 2) derivation of *Declinognathodus donetzianus* from *D. marginodosus*. Both lineages have short comings and if either *D. donetzianus* or *I. postsulcatus* are chosen, the group's challenge will be to demonstrate how the base of the Moscovian can be identified in areas where these taxa do not occur. Nevertheless, the *D. marginonodosus-D. donetzianus* lineage remains a candidate for the event level.

A third potential marker the task group has been evaluating is the appearance of the conodont *Diplognathodus ellesmerensis*, which appears at the base of the Moscovian in the Naqing section (Nashui) in Guizhou Province, China (Qi *et al*., 2007, 2009) and has been widely recognized globally. If a morphologic chronocline can be demonstrated from the ancestral species to *D. ellesmerensis* at Naqing, it would provide an almost ideal level for the GSSP. In former years it was thought that *Diplognathodus coloradoensis* Murray & Chronic, 1965 was the immediate ancestor of *D. ellesmerensis*; however, additional work on ancestry of *D. ellesmerensis* is required. The interval spanning the Bashkirian-Moscovian boundary at Nashui is undergoing intensive biostratigraphic and sedimentologic study as a potential GSSP for the base of the Moscovian.

The carbonate-dominant Naqing section in Guizhou Province is one of the best candidates for the GSSP at the base of the Moscovian because the conodonts being considered for boundary definition are abundant and their first occurrences precisely located. Foraminifers are also present and have been thoroughly investigated (Groves, 2010). Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary

interval at Nashui are less advanced than the paleontological investigations and will be the focus of the team's work in 2014 and 2015. In order to place the important Nashui section into its sedimentological and paleoenvironmental context and to determine the relationship of shallow-water coral and foraminiferal zones to the deeper-water conodont markers within the Bashkirian-Moscovian transition in south China, the investigation of two reference sections - the Zhongdi, and the Luokun sections - will continue.

Because substantial work still is still required before a GSSP can be selected, 2016 is the earliest likely completion date.

Moscovian-Kasimovian Boundary and Kasimovian-Gzhelian Boundary Task Groups

Moscovian-Kasimovian Stage Boundary The high-priority plans for the Moscovian-Kasimovian task group during the next four years are to select an event marker for the Moscovian-Kasimovian boundary and then to search for GSSP candidate sections. Task-group members, who attended the 2008 Oviedo meeting, reached unanimous agreement to focus future work on two conodont species as the potential biostratigraphic marker by which the base of the Kasimovian can be selected and correlated globally. The first is *Idiognathodus sagittalis*, based on material from the Donets Basin (Ukraine) and also identified from the Moscow region and southern Urals of Russia, and the Cantabrian Mountains (Spain). A potential ancestor-descendent lineage from *I.* aff. *sagittalis* n. sp. to *I. sagittalis* may be present in the Moscow region. The second potential marker is *Idiognathodus turbatus* based on material from the Midcontinent region of the U.S.A., and also recognized in the Moscow Basin, the southern Urals, and the Donets Basin. A lineage from *Idiognathodus swadei* to *I. turbatus* has been described from the U.S. Midcontinent. A new option that was presented in 2013, is to use the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013. *I. heckeli,* the precursor species to *I. turbatus*, might be a more appropriate marker because its first appearance is closer to that of the traditional definition of the Kasimovian than that of either *Idiognathodus sagittalis* or *Idiognathodus turbatus*. *Idiognathodus heckeli* is also present in the Naqing section in Guizhou Province of South China, which would allow that section to serve as the GSSP for the base of the Kasimovian. While the event marker for the Moscovian-Kasimovian boundary still needs to achieve consensus, continued assessment of the lineages and clarification of the taxonomy of species involved will hasten the process.

The task group will continue to evaluate the utility of the three lineages in the slope-deposits of the Naqing section, a good potential candidate section for the GSSP. Other candidate sections need to be located and intensively studied.

Kasimovian-Gzhelian Boundary Members of the Kasimovian-Gzhelian task group plan to use the conodont lineage *Idiognathodus eudoraensis - I. simulator s.s.* to define the boundary at the first appearance of *I. simulator s.s*. Now that an event maker has been selected, task-group members will proceed on selecting a suitable section for the GSSP. So far only the Usolka section in the southern Ural Mountains of Russia has been proposed as a candidate section for the GSSP (Davydov *et al*., 2008); other proposals are required.

The widespread disconformities within the Kasimovian-Gzhelian transition across most of the shelf regions presents a substantial problem for selecting a section for the GSSP**,** but work on the essentially complete carbonate-slope sections in the southern Urals (Usolka River section) and on the slope deposits in the Nashui section, are providing more appropriate sections for a potential GSSP. Conodont studies are well advanced at the two localities, but sedimentologic, geochemical and geophysical studies at the sections are at an early stage. Gusal Sungatullina (Kazan University, Russia) is restudying the conodonts across the boundary within the Usolka section. Alexander Alekseev is strongly expecting the results of Gusal's study to be sufficient to propose using the Usolka section as a potential GSSP candidate for the base of the Gzhelian.

Therefore, 2014 - 2016 is probably the earliest a GSSP for the boundary will be selected and approved.

Chemostratigraphy, magnetostratigraphy and radiometric dating

The SCCS executive is hopeful that ongoing work in chemostratigraphy and magnetostratigraphy will identify events that can be used to supplement the boundaries that will be defined by means of faunal events, and will eventually provide the basis for correlating these boundaries into the northern-hemisphere Angara region and the southern-hemisphere Gondwana region, where the pan-tropical biotas are replaced by provincial cold-climate communities. We are also hopeful that new, precise radiometric dating on biostratigraphically well-constrained marine successions, such as are being reported from the Pennsylvanian of the southern Urals by the Boise State group will both narrow the age disparities that currently exist within much of the Carboniferous and also provide better correlation with more precise modern radiometric dates that will hopefully be obtained from the Angara and Gondwana regions.

ORGANIZATION AND SUBCOMMISSION MEMBERSHIP

In addition to the three executive voting members, the SCCS has 17 rank-and-file voting members and approximately 280 corresponding members (see latest issue of Newsletter on Carboniferous Stratigraphy for contact information). During the year, the subcommission comprised five task groups and one project group.

Working groups/task groups and officers

Task Group to redefine the Devonian-Carboniferous Boundary [which is also the base of the Lower Mississippian Series and Tournaisian Stage] is a task group established in early 2008 that is chaired by Markus Aretz (France; aretz[at]get.obs-mip.fr); Carlo Corradini is the Vice-chairman.

Task Group to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series] is chaired by George Sevastopulo (Ireland; gsvstpul[at]tcd.ie).

Task Group to establish the Viséan-Serpukhovian Boundary [which is also the base of the Upper Mississippian Series] is chaired by Barry Richards (Canada; barry.richards[at]NRCan.gc.ca).

Task Group to establish the Bashkirian-Moscovian Boundary [which is also the base of the Middle Pennsylvanian Series] is chaired by Alexander Alekseev (Moscow State University, Russia; aaleks[at]geol.msu.ru).

Task Group to establish the Moscovian-Kasimovian Boundary [which is also the base of the Upper Pennsylvanian Series], and the **Kasimovian-Gzhelian Boundary** is chaired by Katsumi Ueno (Japan; katsumi[at]fukuoka-u.ac.jp).

Project Group on Carboniferous magnetostratigraphy, chaired by Mark Hounslow (United Kingdom), who did not submit a progress report this year for the Newsletter on Carboniferous Stratigraphy but summarized the recent work of the group through June 2009 in volume 27 of the Newsletter on Carboniferous Stratigraphy.

INTERFACE WITH OTHER INTERNATIONAL PROJECTS

The SCCS works closely with the subcommissions and task groups on Devonian (SDS) and Permian Stratigraphy (SPS) to establish the common boundaries with the Carboniferous. The SCCS expects to cooperate with the NSF-sponsored Chronos initiative, which has a website at www.chronos.org, and with the NSF-sponsored PaleoStrat community digital information system for sedimentary, paleontologic, stratigraphic, geochemical, geochronologic, and related data, hosted at Boise State University, and with a website at www.paleostrat.org. It also has established a working relationship with the Permian Research Group at Boise State, which has initiated a program of obtaining precise ID-TIMS U-Pb radiometric dates from biostratigraphically constrained uppermost Devonian to Permian successions in the Ural Mountains and elsewhere.

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SUMMARY OF EXPENDITURES

Statement of operating accounts from November 1, 2012 to October 30, 2012

prepared by Barry Richards, Chairman SCCS

(Accounts maintained in Canadian currency)

INCOME (November 1, 2012 – October 31, 2013)	
IUGS-ICS Grant	$0.00
Donations from Members; November 1, 2012 - October 31 2013	$0.00
Interest Bank of Montreal; November 1, 2012 - October 31, 2013	$0.00
TOTAL INCOME	**$0.00**
EXPENDITURES (November 1, 2012 – October 31, 2013)	
Bank Charges: Bank of Montreal	$0.00
Travel and conference registration support for SCCS voting members and executive to attend and give oral presentations (no requests)	$0.00
TOTAL EXPENDITURE	**$0.00**
BALANCE SHEET (2012 – 2013)	
Funds carried forward from October 31, 2012	$706.62
Plus Income November 1, 2012 – October 31, 2013	$0.00
Total assets	**$706.62**
Less Expenditures November 1, 2012 – October 31, 2013	0.00
BALANCE CARRIED FORWARD (to 2013 – 2014 fiscal year)	**$706.62**

BUDGET AND ICS COMPONENT FOR NOV. 1, 2012 – OCT. 31, 2013 FISCAL YEAR

Prepared by Barry Richards, Chairman SCCS

PROJECTED EXPENSES	
Travel support for SCCS Chairman and other voting members to attend March SDS/SCCS workshop (Devonian and L. Carboniferous of northern Gondwana) in Morocco	$1,000.00
TOTAL Projected Expenses	**$1,000.00**
INCOME	
Carryover (from CREDIT balance at end Nov. 1, 2011 – Oct. 31 2012 fiscal year)	$706.62
Estimated donations	$200.00
TOTAL PROJECTED INCOME	**$906.62**
BALANCE	
Estimated (deficit) / credit from above	-$1,843.38
Budget request from ICS for 2012	$1,000.00

TASK-GROUP REPORTS FOR THE NOV. 1ST, 2012 TO OCT. 31ST, 2013 FISCAL YEAR

REPORT OF THE JOINT DEVONIAN–CARBONIFEROUS BOUNDARY GSSP REAPPRAISAL TASK GROUP

Markus Aretz and Task Group

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Introduction and general activities

The Devonian-Carboniferous (D-C) boundary task group is conducting paleontologic and multi-disciplinary research on several continents. During the fiscal year, the group continued with it primary tasks (see Richards & task group, 2010; Aretz 2011) – the search for a suitable criterion for redefinition of the D-C boundary and the hunt for a suitable section for the GSSP. Studies by Ji *et al*. (1989) and subsequent analysis (Kaiser, 2009) demonstrated severe problems exist with the D-C boundary GSSP (Paproth *et al*., 1991) at La Serre Hill, France. The boundary at La Serre is currently defined by the first occurrence of the conodont *Siphonodella sulcata* (Huddle, 1934) in the lineage *Siphonodella praesulcata* Sandberg, 1972 to *S. sulcata.* During the 2013 fiscal year, the working-group's most important conference activity was attending the SDS/SCCS workshop at Erfoud, Morocco (March 22nd to 29th, 2013). Informal discussions between task-group members and non-members were also held at the 3rd International Conodont Symposium in Argentina (ICOS 2013) and the 1st International Congress on Stratigraphy (July 1st to 7th, 2013) in Lisbon, Portugal.

Erfoud Conference

At the Erfoud conference and field meeting, most of the problems for recognizing and defining the D-C boundary were discussed and demonstrated in the field and during workshops. The conference presentations and workshop discussions confirmed the issues that had been identified in previous years. There is still no general agreement for two major questions. 1) Can the level of the current D-C boundary defined by the GSSP at La Serre, be used for global stratigraphic correlations? 2) Can a marker conodont be found among either the siphonodellids or protognathodids? All possible combinations of answers to those two questions exist within the scientific community and the task group.

Discussions at Erfoud and results presented by Becker *et al.* (2013) in the conference guidebook for the Moroccan sections also showed the very different approaches used for conodont taxonomy in the biostratigraphically important conodont genera. Thus the lack of a uniform approach makes it impossible to precisely correlate the boundary when using the common conodont taxa. Miscorrelations due to different species concepts have contributed substantially to the current problems of D-C boundary definition and correlation.

Researchers at Erfoud agreed on several points that should provide guidelines for further activities and discussions.

a. All potential criteria for the D-C boundary definition require study. The new boundary definition does not need to be a conodont.

b. A multidisciplinary approach should be used for boundary definition. The presence or absence of a single criterion cannot be the only argument for placing the boundary.

c. If the boundary level has to be changed, it should not be raised into the Tournaisian.

d. The major late Famennian extinction (Hangenberg Event) is a good potential candidate for a new definition of the boundary, but additional detailed stratigraphic data are required before it can be used.

In a final discussion, task-group members agreed that a principal goal for the 2013-2014 fiscal years is the compilation of detailed data sets for the best boundary sections throughout the world. The task-group leader was also asked to revise the composition of the task group to better reflect the researchers actively working on the boundary. Both tasks have required more time than expected (mainly due to the workloads of the task-group leaders) but they should be completed in 2014.

Reports from members

H. Matyja (Warsaw, Poland) & co-authors (Sobień, K., Marynowski, L., Stempień-Sałek, M., & Małkowski, K.) completed, a manuscript about a complete sequence of the uppermost Famennian to lowermost Tournaisian in the Pomeranian Basin (northern Poland). The interval was analyzed in detail using biostratigraphy, sedimentology, magnetic susceptibility, and geochemistry in a reference section comprising relatively shallow-shelf deposits. The sedimentary succession and specific phenomena recognized close to the D-C boundary display a pattern similar to that formed in

many areas in Europe during the Hangenberg Event, although the Hangenberg Black Shale horizon is not developed in northern Poland. Studies similar to those in the Pomeranian Basin have been initiated on the best sections in southern Poland.

C. Corradini (Cagliari, Italy) & **C. Spalletta (Bologna, Italy)** are working on sections from various successions (mainly in Sardinia and the Carnic Alps) that were deposited on northern Gondwana. In Sardinia, the Monte Taccu section (Corradini *et al*., 2003) has been restudied using new samples (Mossoni *et al*., 2013) but the D-C boundary is not present and the first limestone after above the Hangenberg equivalent shales (Middle *praesulcata* Zone) is within the Lower *duplicata* Zone. Work on a new section a few km eastward is in progress, and they plan to complete that work in the next few months.

Corradini *et al*. (2013) published an important summary about the main conodont genera across the D-C boundary. The paper provides an overview of the main latest Devonian and earliest Carboniferous conodont genera: beside *Siphonodella*, the distributions of potentially important species of *Protognathodus, Bispathodus, Polygnathus, Pseudopolygnathus* and other genera are analyzed to determine their potential for biostratigraphy across the D-C boundary. Corradini along with Hanna Matyja and Sandra Kaiser are continuing the conodont study and plan to submit a more comprehensive manuscript within 2014.

A latest Frasnian-earliest Tournaisian section (Col des Tribes) in Montagne Noire was studied in a project led by Catherine Girard. Unfortunately the DCB beds are not so well exposed.

Barry Richards (Calgary, Canada) & colleagues (Mark Schmitz & Vladimir Davydov at Boise State, Idaho; Jeffrey Over at SUNY-Geneseo, New York; Tim Hartel, Calgary) continued studies of the upper Famennian to lower Tournaisian (includes Exshaw and Bakken formations) in the Western Canada Sedimentary Basin (WCSB) and adjacent Montana to see if the main events in the multi-phase Hangenberg Event Interval (Kaiser *et al*., 2008), can be more precisely located in the region using a multidisciplinary approach combining U-Pb radiometric dating (Thermal Ionization Mass Spectrometry CA-TIMS), stable carbon isotope chemostratigraphy ($\delta^{13}C$), conodont biostratigraphy, and magnetic susceptibility. Activities included processing of volcanic ash collected from the Exshaw and Banff during previous years for U-Pb dating and the sampling of the Exshaw black shale at three outcrop sections (Jura Creek, Mount Rundle, and Highway 3 at Crowsnest Lake) in the southern Canadian Rockies for stable carbon isotope ($\delta^{13}C$) chemostratigraphic and magnetic susceptibility studies. The upper Palliser, Exshaw and lower Banff formations were measured and sampled for U-Pb dating, carbon isotope ($\delta^{13}C$) chemostratigraphy and magnetic susceptibility on Turtle Mountain by Blairmore, Alberta.

Conodonts from the Exshaw and high-resolution U-Pb dates (ID-TIMS) from its black shale member (Richards *et al*., 2002; Johnston *et al*., 2010) indicate the onset of wide-spread anoxia in the WCSB and main phase of black shale deposition occurred prior to the Middle *praesulcata* Zone and the transgressive phase of the Hangenberg Event in Western Europe. In much of the basin, anoxia continued into the *Siphonodella duplicata* Zone and the position of the maximum flooding surface is diachronous.

Conodont data indicate the contact between the Devonian and Carboniferous lies in the upper part of the black-shale member of the Exshaw at several sections including the one on Jura Creek and Mount Rundle but the position of the D-C boundary has not been precisely located. New data from the CA-TIMS analyses has further constrained the position of the boundary in three sections and indicate strata within the Middle *Praesulcata* Zone are preserved in the black-shale member. Carbon isotope studies require completion to determine the location of the typical positive ($\delta^{13}C$) excurion at the onset of the Hangenberg.

B. Ellwood (Baton Rouge) & colleagues have been looking at possible D-C boundary localities in Turkey and Oklahoma. They hoped to locate a good section in Turkey but their best candidate had structural complexities at the boundary level. The work in Oklahoma was on the Woodford Shale at two localities, and the work included a core from Indiana. This work was done in conjunction with Jeff Over at SUNY Geneseo who studied the conodonts. An MS thesis resulted from the work, but due to the lack of biodiversity, neither of the Oklahoma outcrop sections are suitable candidates for the GSSP.

Task group work plans 2014

A biostratigraphic analysis by Ji Qiang & his colleagues (Ji *et al*., 1989) and further work (Kaiser, 2009) indicates there are problems with the D-C Boundary GSSP (Paproth *et al*., 1991) at La Serre, France and the conodont lineage used for boundary definition. Therefore, the primary tasks for the D-C boundary task group are to locate a suitable event marker to define the boundary and the find a suitable section for the GSSP. To help achieve these goals, work in 2014 will focus on the compilation of detailed data sets for the best boundary sections throughout the world. Data to be integrated will be derived from the evaluation of lithology and facies,

distribution of fauna and flora, and geochemical and geophysical data.

Considerable progress on re-evaluating all of the conodonts within the D-C boundary interval including the current D-C boundary marker, the FAD of the conodont *S. sulcata,* has been made (Corradini *et al*., 2013). Additional study of the conodonts is required, however, and the task group plans to complete that work shortly. Several task-group members have been studying the taxonomic and phylogenetic problems within the protognathodid conodont lineages (Corradini *et al*., 2011; Corradini *et al*., 2013). Four species of *Protognathodus* are known from the relevant time span: *Protognathodus meischneri, P. collinsoni, P. kockeli* & *P. kuehni. p*resently favoured for boundary definition are the first occurrences of *P. kockeli* from *P. collinsoni* & *P. kuehni* from *P. kockeli.* The SCCS executive has asked the conodont specialists to evaluate the utility of using the lineages for boundary definition by studying them in the best of their D-C boundary sections.

At recent meetings, it has been proposed that the task group consider using some component of the multiphase Hangenberg Event Interval (Kaiser *et al*., 2008) for boundary definition. Markus Aretz asked members to prepare for the D-C boundary workshop in Erfoud Morocco (March 22nd to 29th, 2013; see circular in v 29 of Newsletter on Carboniferous Stratigraphy), by developing precise correlation charts for the best D-C boundary sections in their regions of study showing the biostratigraphic, geochemical and depositional events within the Hangenberg Event interval. The data sets had not been completed for the meeting and Markus Aretz is requesting the work be completed during 2014.

Several of the ongoing D-C boundary projects that are planned for next four to five years are outlined below. 1) Yuriy Gatovsky and Lyudmila Kononova (Moscow State University) plan to complete a monograph on the conodont biostratigraphy of D-C boundary interval in the Ural Mountains of Russia. The study will consider the interval from the Famennian *marginifera* Zone into the Tournaisian *isosticha* Zone. 2) Chinese colleagues along with the SCCS executive and task-group leaders initiated a re-assessment of the best D-C boundary sections in China by visiting the Dapoushang section (Ji *et al*., 1989) in southern Guizhou Province. 3) Task-group member Jiri Kalvoda & colleagues from the Czech Republic are conducting a multidiscipline project to study the D-C boundary interval in Western and Central Europe including the La Serre section. The project's principal goal is the correlation of evolutionary changes in foraminifer and conodont faunas in the D-C boundary interval with a high-resolution stratigraphic framework arising from multidiscipline stratigraphic-paleoenvironmental analysis. Anticipated benefits of the project for the ICS and SCCS are a better understanding of the *S. praesulcata - S. sulcata* lineage and whether or not it is suitable for definition of the D-C Boundary GSSP. Other conodont lineages relevant to the boundary (protognathodids lineages) will also be evaluated. The resulting high-resolution stratigraphy will be used to test the isochroneity of the events within the Hangenberg Event Interval and contribute to a better correlation between basinal and shallow-water successions. 4) In western Canada, Barry Richards & several colleagues (include Mark Schmitz and Vladimir Davydov at Boise State, Idaho; Jeffrey Over at SUNY-Geneseo, New York; Tim Hartel, Calgary) intend to continue ongoing studies of the latest Famennian to early Tournaisian Exshaw Formation (see Richards *et al*., 2002) and its correlatives to see if the main events in the multi-phase Hangenberg Event Interval can be more precisely located in the formation by using a multidisciplinary approach that includes radiometric dating and stable carbon isotope ($\delta^{13}C$) stratigraphy. 5) Carlo Corradini has several ongoing projects related to the D-C boundary study in various part of northern Gondwana. 6) Thomas Becker (Münster) and his research group plan to continue their investigation of the D-C boundary transition in Morocco, particularly in the SE Anti-Atlas Mountains.

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TASK GROUP TO ESTABLISH THE TOURNAISIAN-VISÉAN BOUNDARY

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Following approval of the proposed GSSP (Devuyst *et al.,* 2003) at Pengchong in southern China, by the SCCS in late 2007 and its ratification by the ICS and IUGS, task-group member François-Xavier Devuyst had been preparing the final report about the Tournaisian-Viséan boundary GSSP but the task-group chairman George Sevastopulo has taken over that role.

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REPORT OF THE TASK GROUP TO ESTABLISH A GSSP CLOSE TO THE EXISTING VISÉAN–SERPUKHOVIAN BOUNDARY

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Introduction

An index for boundary definition has been selected, but not voted on by the task group and SCCS for final approval, and work is well advanced at the two prime GSSP candidate sections: the Verkhnyaya Kardailovka in the southern Ural Mountains of Russia and the Naqing (Nashui) section in southern Guizhou Province, China. Work continued on other potential candidate sections for the GSSP in the Cantabrian Mountains of northwest Spain. For boundary definition, the group is using the first evolutionary appearance of the conodont *Lochriea ziegleri* Nemirovskaya, Perret & Meischner, 1994 in the lineage *Lochriea nodosa* (Bischoff, 1957) –*Lochriea ziegleri. L. ziegleri* appears in the Brigantian Substage of NW Europe somewhat below the current base of the Serpukhovian as defined by its lectostratotype section in the Zaborie quarry near the city of Serpukhov in the Moscow Basin,

Russia (Kabanov *et al*., 2009, 2012, 2013). Task-group members are conducting research on biostratigraphy, sedimentology and lithostratigraphy, stable-isotope geochemistry and magnetic susceptibility at several locations in Western Europe, Russia, China and North America.

The most important accomplishments were: 1) the publication of a comprehensive study of the conodonts spanning the Viséan-Serpukhovian boundary in the Naqing section in South China (Qi *et al*. 2013), 2) the publication of a paper about the degree of diachroneity at the proposed base of the Serpukhovian in NW Europe as defined by the first appearance of *L. ziegleri* and correlating that FAD with the ammonoid zones (Sevastopulo & Barham, 2013), and 3) the completion of a sedimentologic-biostratigraphic (ammonites and conodonts) study across the boundary level in the Verkhnyaya Kardailovka section (Richards *et al*., in press). In addition, field work on several Viséan/Serpukhovian boundary sections was completed in southern Guizhou Province of China, and the systematic evaluation of conodonts within the genus *Lochriea* continued.

Progress in southern Guizhou province, China

In the Naqing (Nashui) section in southern Guizhou province, the Viséan-Serpukhovian boundary is currently placed at 60.1m above the base of the original section measured by Qi & Wang (2005), which is equivalent to a position 17.94 m above the base of the new section measured and permanently marked by aluminum pins by the task group in 2008. In the deep-water turbiditic Nashui section, conodonts within the *Lochriea nodosa* – L*ochriea ziegleri* lineage are well preserved and abundant. Qi *et al*., (2013) published an important paper about the conodonts and sedimentology of the boundary interval in the Nashui section. The boundary interval in that section was sampled for stable-carbon isotopes at 10 cm intervals on either side of boundary. In October, a bed-by-bed study (measurement of bed thicknesses, description of beds, and collection of large blocks for cutting and observation of sedimentary structures and grading) was completed across boundary level from the base of the section to the 31.39 m level.

Within the same general region of southern Guizhou as the Naqing section, the Luokun and Narao sections were measured across the Viséan/Serpukhovian boundary, as defined by the FAD of *L. ziegleri*. Those sections, dominated by limestone turbidites, were measured in order to better place the important Naqing section within its depositional context. The sections were measured at bed-by-bed level of detail and sampled for conodonts and stable carbon isotopes.

Task-group member Paul Brenckle is continuing with the ongoing study of foraminifers in the Naqing section and several other sections in the region including the important Yashui section discussed by Groves *et al*. 2012. Groves *et al*. found that the base of the Serpukhovian in southern Guizhou could be approximated using foraminifers but a precise correlation with the FAD of *L. ziegleri* in the Nashui section could not be established because of the lack of foraminiferal indices for the boundary in the Naqing section and the paucity of conodonts through the boundary level at Yashui. The foraminiferal successions across this boundary in the type area of the Serpukhovian Stage in the Moscow Basin of Russia (Kabanov *et al*., 2009; Gibshman *et al*., 2009), the Uralian region of Russia (Nikolaeva *et al.,* 2005; 2009a,b) and in the central United States suggest that the appearances of *Asteroarchaediscus postrugosus* (Reitlinger, 1949), *Janischewskina delicate* (Malakhova, 1956), "*Millerella*" *tortula* Zeller, 1953 and *Eolasiodiscus donbassicus* Reitlinger, 1956 are useful auxiliary indices to the base of the Serpukhovian. It is anticipated the work by Paul Brenckle using material from several new sections (including those by villages of Luokun, Narao, and Dianzishang) in addition to those at Naqing and Yashui will permit a more precise correlation.

Progress in southern Urals,

During the fiscal year, no field work was done in the southern Urals but a lithostratigraphic-sedimentologic-biostratigraphic (ammonites and conodonts) study across the boundary level in the Verkhnyaya Kardailovka section (Richards *et al*., in press) was completed. The Verkhnyaya Kardailovka section, situated along the Ural River opposite the village of Verkhnyaya Kardailovka on the eastern slope of the southern Ural Mountains, contains volcanics and turbiditic siltstone and sandstone in its lower part but most of the section including the succession spanning the Viséan-Serpukhovian boundary comprises deep-water limestone. Nikolaeva and her colleagues have worked on the Kardailovka section for several years and published several syntheses about the ammonoids, conodonts, foraminifers and ostracodes (Nikolaeva *et al*., 2009b; Pazukhin *et al*., 2010). Their syntheses demonstrate the first evolutionary appearance of *L. ziegleri* occurs in the lower part of the limestone-dominant component of the section immediately above an interval containing elements transitional between *L. nodosa* and *L. ziegleri*. In the section documented by Richards *et al*. (in press) the first occurrence of *L. ziegleri* is at 19.7 m above the base of the section. Svetlana Nikolaeva made large collections of ammonites from the newly excavated boundary interval at Verkhnyaya Kardailovka in August 2012 and her results (Nikolaeva, 2013) are

summarized here. Three ammonoid assemblages are recognized in the Viséan – Serpukhovian Boundary beds in the Verkhnyaya Kardailovka section and are assigned to: the *Goniatites* Genozone (Upper Viséan), *Hypergoniatites–Ferganoceras* Genozone (Upper Viséan and Lower Serpukhovian), and the *Uralopronorites–Cravenoceras* Genozone (Lower Serpukhovian). An additional progress report about the ammonoids, conodonts, and foraminifers across the Viséan-Serpukhovian boundary in the Kardailovka section in Russia (Nikolaeva *et al*. 2014, in press) was also completed during the fiscal year. The latter study focused on microfacies and the biostratigraphy of ammonoids, conodonts and foraminifers in a one metre thick interval (between 19.0 and 20.0 m above the base of section 11RAH10 of Richards *et al*., in press) spanning the boundary.

Progress Moscow Basin, type area of Serpukhovian

Recent biostratigraphic and sequence stratigraphic studies in the type area of the Serpukhovian in the Moscow Basin (Kabanov *et al*., 2013) reveal that the first appearance of *Lochriea ziegleri* is in the uppermost Venevian Substage of the Viséan (about 3 m below its top) rather than in the lowermost Tarusian Substage of the Serpukhovian as previously reported. Nikolaeva *et al*. (2002) and Kabanov *et al*. (2009) reported that in the Zaborie quarry section, lectostratotype of the Serpukhovian Stage, *L. ziegleri* appears with *Lochriea senckenbergica* Nemirovskaya, Perret & Meischner, 1994 in the basal bed of the Tarusian.

Task group work plans 2014

The task group has determined that the FAD of the conodont *Lochriea ziegleri* in the lineage *Lochriea nodosa–Lochriea ziegleri* is the best index for boundary definition and plans to draft a proposal advocating the use of that index. During the 2014 fiscal year, the team will continue to direct its attention toward selecting the best candidate section for the GSSP. The best two candidate sections are the Naqing (Nashui) section by the village of Naqing in southern Guizhou Province, China and the Verkhnyaya Kardailovka section on the Ural River in southern Russia.

Activities in South China

The deep-water (slope), carbonate-dominant Naqing section in southern China is an excellent candidate for the GSSP at the base of the Serpukhovian because the *L. nodosa–L. ziegleri* lineage is well defined and the FAD of *L. ziegleri* has been precisely located. The conodont studies for the locality are essentially complete and the FAD of *L.* ziegleri is located (Qi *et al*., 2010; 2013). Qi Yuping and Tamara Nemyrovska plan to complete a manuscript on the systematics and phylogeny of conodonts within the genus *Lochriea* from the Naqing section.

Groves *et al*. (2012) completed a study of the foraminifers in the Naqing section, thereby finishing a major part of the work needed for that important fossil group in China. Important questions remained unanswered, however, and task-group member Paul Brenckle is continuing with the study of foraminifers in the Naqing section and several other sections in the region including the important Yashui and Dianzishang sections (see Groves *et al*. 2012). Groves *et al*. found that the base of the Serpukhovian in southern Guizhou could be approximated using foraminifers but a precise correlation with the FAD of *L. ziegleri* in the Nashui section could not be established because of the lack of foraminiferal indices for the boundary in the Naqing section and the paucity of conodonts through the boundary level at Yashui.

Work on the sedimentology, stable-isotope geochemistry, and geophysical characteristics of the boundary interval are less advanced than the paleontological investigations and will be the focus of the team's work in the next two fiscal years. To place the Naqing section into its sedimentologic and paleoenvironmental context and to determine the relationship of shallow-water coral zones to the deeper-water *L. nodosa* - *L. ziegleri* transition in south China, the investigation of four reference sections - the Yashui, Dianzishang, Luokun, and Narao sections - will continue.

The most important reference section for Naqing is the Yashui section, near the city of Huishui in Guizhou province. It is an important section because it contains abundant well-preserved rugose corals and foraminifers (Wu *et al*., 2009; Groves *et al*., 2012) and is dominated by shallow-marine, neritic- to peritidal-ramp facies. In 2010 the Yashui section was measured and described by at a bed-by-bed level of detail and sampled by team members for lithology, conodonts, foraminifers, and rugose corals. Investigations on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the section are less advanced than the paleontological work and will be the focus of the team's work in 2014.

Strata in the Dianzishang section, situated by Dianzishang village along the Zin Zai River 1 km upstream from the Red Flag Bridge, are intermediate between the lower-slope to basin deposits at Nashui and the shallow-marine ramp deposits at Yashui. The Dianzishang section includes spectacular syndepositional slump deposits formed in slope settings and provides another opportunity to see conodonts and foraminifers spanning the *L. nodosa- L. ziegleri* transition in the region. Conodont

work at the locality is continuing to more precisely locate the position of the Viséan/Serpukhovian boundary using the *L. nodosa* - *L. ziegleri* transition. Work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the boundary interval and section are not as advanced as the paleontological studies and will be an important aspect of the work at the locality in the next two fiscal years.

During 2010, the task group commenced measuring and sampling of the Luokun section near the village of Luokun several kilometres from Naqing and the Nashui section. Like the Nashui section, the exposure at Luokun is essentially 100% complete but dominated by slope carbonates of that are more proximal aspect than those at Naqing. Study of the section will provide another opportunity to see conodonts and foraminifers spanning the *L. nodosa- L. ziegleri* transition in the region. Foraminifers are more abundant and better preserved than at Nashui, and it is anticipated that a better correlation between conodonts and foraminifers can be achieved by the study of the Luokun section. During 2013, the task group completed the measurement and sampling of the boundary level in that section at a bed-by-bed level and plans to process the samples in 2014.

Activities in Southern Urals, Russia

With conodonts of the *L. nodosa-L. ziegleri* transition, abundant ammonoids, and moderately common foraminifers, the Kardailovka section, a deep-water, basinal-carbonate succession on the Ural River near the village of Verkhnyaya Kardailovka in the Urals remains the other strong candidate for the Viséan-Serpukhovian boundary GSSP. Conodonts, foraminifers and ammonoids in section have been studied in detail (Nikolaeva *et al*., 2009; Pazukhin *et al*., 2010) but additional work across the boundary level is required. Sufficient conodont work been done to locate the approximate position of the FAD of the conodont *L. ziegleri* but additional processing of the closely-spaced samples obtained in 2011 and 2012 is required to more completely document the transition and precisely locate the FAD of *L. ziegleri*.

Work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the section are somewhat less advanced than the paleontological work and will be a focus of the team's investigations in 2014. The team has prepared a preliminary paper on the lithostratigraphy and sedimentology of the lower part of the section including the boundary interval for publication in the Geological Magazine (Richards *et al*., in press). The team will be showing the section on a field trip associated with the XVIII International Congress on the Carboniferous and Permian in Kazan, Russia in August 2015 and plans to have a sedimentological study of the entire section up to the base of the Bashkirian completed for that event. The Kardailovka section contains numerous volcanic ash layers near the boundary level and the task group plans is having the most important ashes dated using the U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology.

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REPORT OF THE TASK GROUP TO ESTABLISH A GSSP CLOSE TO THE EXISTING BASHKIRIAN–MOSCOVIAN BOUNDARY

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Introduction

Important progress was made toward the selection of a marker species and suitable section for the GSSP at the base of the Moscovian Stage during the fiscal year. Although more than 10 conodont and fusulinid taxa have been proposed as potential markers for the GSSP over the last several

years, only two conodont species (*Declinognathodus donetzianus* Nemirovskaya, 1990 and *Diplognathodus ellesmerensis* Bender, 1980) are currently considered to have substantial potential for definition of a boundary position close to the original base of the type Moscovian. The relatively restricted geographic distribution of most of the other proposed taxa was the most important factor limiting their utility for boundary definition. Several candidate sections for the GSSP are being studied but the Naqing section in southern Guizhou province of South China appears to have the best potential (Qi *et al*., 2010). The Basu River section (Kulagina *et al*., 2009) in the southern Urals of Russia is undergoing intensive study in preparation for the a field trip for XVIII International Congress on Carboniferous and Permian that will be held in Kazan, Russia on August 7-15, 2015.

Moscow Basin

The recent suggestion (Goreva & Alekseev, 2012; Alekseev & Goreva, 2013) to shift the base of the Moscovian one substage higher - from the base of the Vereian regional Substage (lowermost Moscovian substage of stratotype in Moscow Basin) to the base of Kashirian regional Substage using the first appearance of the conodont *Neognathodus bothrops* Merrill, 1972 - received negligible support from the task group. Task group member Tamara Nemyrovska said the proposal was interesting but *Neognathodus* is scarce in most regions except the Moscow Basin and North America. The proposed marker for the new level is the FAD of *Neognathodus bothrops* from its ancestor *Neognathodus atokaensis* Grayson, 1984 as established in the Yambirno quarry section (Kabanov & Alekseev, 2011a, b) in the Ryazan Region about 400 km southeast of Moscow. Analysis of ranges of fusulinid taxa in the Yambirno section show that important changes took place close to the base of the Kashirian Substage (Isakova, 2013) at the FADs of *Hemifusulina* or *Priscoidella* and development of the first diaphanotheca (wall of 4 layers).

Guizhou Province, South China

Task-group members Qi Yuping, Tamara Nemyrovska, & Lance Lambert continued their study of the Bashkirian/Moscovian interval in the deep-water (slope), limestone-dominated Naqing (Nashui) section in South China. The succession of transitional conodont morphoclines in that completely exposed, open-marine section demonstrates that deposition was essentially continuous through the turbidite-dominated Bashkirian-Moscovian boundary interval. Conodont diversity is high, and every bed in the boundary interval has been productive. The multiple transitional morphoclines there provide many possible candidates to characterize a level for the GSSP at the base of the Moscovian Stage. The one that best matches the current concept for the base of the Moscovian in its type region (Moscow Basin), and with the greatest potential for intercontinental correlation, is the phylogenetic first occurrence of *Diplognathodus ellesmerensis*. This species is easily recognized by conodont workers and has been recovered from China, Western and Eastern Europe (Moscow Basin and South Urals), boreal Canada (from where it was named; Bender, 1980), and South America. That makes it one of the most widely recovered conodont species in the Upper Carboniferous. Notably, it has been recovered from the basal marine unit (Alyutovo Formation) of the type Moscovian (Makhlina *et al*., 2001). If a morphologic chronocline can be demonstrated from the ancestral species to *D. ellesmerensis* at Naqing, it would provide an almost ideal level for the GSSP. In former years it was thought that *Diplognathodus coloradoensis* Murray & Chronic, 1965 was the immediate ancestor of *D. ellesmerensis*; however, additional work on ancestry of *D. ellesmerensis* is required.

During October, the boundary interval in the Naqing section and several nearby sections (by villages of Naraeo and Luokun) were systematically sampled for stable carbon isotope ($\delta^{13}C$) chemostratigraphy by Qi Yuping & colleagues.

Cantabrian Mountains

Task-group member Elisa Villa received a large collection of thin sections from the Bashkirian/Moscovian transition beds from a section close to the city of Oviedo (Spain, Asturia), from which the fusulinids were previously unknown. The section provided many specimens of *Profusulinella*, *Verella* and *Aljutovella*, among other age diagnostic genera. What is particularly interesting is that the intercalated succession of siliciclastics and carbonates in the interval contain a layer of altered volcanic ash that is situated close to the *Verella* beds can be used for U-Pb radiometric dating.

United States of America

Task-group member Uwe Brand is in the process of compiling the stable Carbon isotope data ($\delta^{13}C$), for the Pennsylvanian at Arrow Canyon (Nevada, USA), which includes the Bashkirian-Moscovian boundary interval.

Task group work plans 2014

The task group plans to continue evaluating conodont lineages suitable for definition of the Bashkirian-Moscovian boundary and it is anticipated that during the 2014 and 2015 fiscal years a lineage and taxon suitable for boundary definition will be selected. The group also plans to continue its search for suitable GSSP candidate

sections particularly in South China, southern Urals, and the Donets Basin.

A major effort will be devoted to the continued study of the conodonts within the Bashkirian-Moscovian transitional interval in the Naqing (Nashui) section and nearby sections in southern Guizhou Province, South China. Special attention will be directed toward the study of the lineage containing *Diplognathodus ellesmerensis* Bender 1980, one of the taxa considered to have the best potential for boundary definition. Qi Yuping, Tamara Nemyrovska, and Lance Lambert are going to do the detailed taxonomy work on the conodonts from the Bashkirian-Moscovian boundary interval in the Naqing section. Neither *Diplognathodus coloradoensis* (Murray & Chronic, 1965) nor *D. orphanus* (Merrill) are considered to be the ancestor of *D. ellesmerensis*. In former years it was thought that *D. coloradoensis* was the immediate ancestor of *D. ellesmerensis*; instead, the ancestor is likely to be a new species and its taxonomic status will need to be proven. *D. ellesmerensis* appears a little above the FAD of *Declinognathodus donetzianus* Nemirovskaya, 1990 in the Donets Basin, Ukraine. In the Naqing section of South China, it appears at 5.25 m above the FAD of advanced/regular "*Streptognathodus expansus*" Igo & Koike 1964, which is 5.60 m below the appearance of *Mesogondolella* fauna (Qi *et al*., 2013).

Another priority for the task group is to make preparations for the showing of the Basu River section (Kulagina *et al*., 2009) in the South Urals of Russia on a fieldtrip associated with the XVIII International Congress on the Carboniferous and Permian in Kazan, Russia in August 2015. Kulagina *et al.* had proposed the Basu River section as potential candidate section for the GSSP at the base of the Moscovian Stage.

The task group also plans to continue with its evaluation of the FAD of *Neognathodus bothrops* Merrill 1972, another conodont considered to have potential for boundary definition (Alekseev & Goreva, 2013). Unfortunately, the use of *N. bothrops* will necessitate moving the base of the Moscovian up one substage from the base of the Vereian regional Substage of Russia (lowermost Moscovian substage) to the base of Kashirian regional Substage of Russia.

Work on the sedimentology, stable-isotope geochemistry and geophysical characteristics of the boundary interval in the Nashui and nearby sections are not as advanced as the paleontological investigations and need to be a focus of the team's work in 2014.

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REPORT OF THE TASK GROUP TO ESTABLISH THE MOSCOVIAN–KASIMOVIAN AND KASIMOVIAN–GZHELIAN BOUNDARIES

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Introduction

In the past fiscal year, the task-group members continued to study the Moscovian-Kasimovian and Kasimovian-Gzhelian stage boundaries in their respective areas. The search continued for an index within an evolutionary lineage for definition of the base of the Kasimovian. Conodont-based proposal have been made for that boundary and are being tested prior to final approval. The first appearance datum (FAD) of a conodont has been formally selected for defining the base of the Gzhelian Stage and the search for a suitable section for the GSSP continues. The following note summarizes the annual activities of the group's research based on reports from the members.

MOSCOVIAN–KASIMOVIAN BOUNDARY

As potential marker events for defining the base of the Kasimovian Stage, Villa and the task group (2008) proposed using the FADs of either the conodont *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009. Their occurrence (near base of Khamovnikian Substage, the second substage of the Kasimovian in current definition) is approximately one substage higher than the traditional base of the Kasimovian (base of Krevyakinian Substage). A new option, discussed below, is to use the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013. Until now, however, no formal proposal for a marker species to define the base of the Kasimovian Stage has been presented. In the last few years, task-group members have been working on sections in North America, South China and Eurasia in order to understand the phylogeny, systematics and distribution of these potential indices.

Progress in North America

Rosscoe & Barrick (2013) documented in detail the morphological transition from *Idiognathodus swadei* Rosscoe & Barrick, 2009 to *Idiognathodus heckeli* Rosscoe & Barrick, 2013 (the transitional form) to *I. turbatus* in the North American Midcontinent succession. There, the steps in this lineage occur in the offshore-marine intervals within a succession of successive cyclothems resulting from eustasy (Rosscoe & Barrick, 2009b). These species are widely distributed across the Midcontinent region and in the cyclic carbonate sections in New Mexico and Utah of the southwestern United States.

Rosscoe & Barrick (2013) pointed out that in North America following the extinction of *Neognathodus* and many *Idiognathodus* species near the end of the Moscovian Age, the surviving *Idiognathodus* forms radiated into new species. The latter were characterized first by the appearance of a persistent eccentric groove (e.g. *I. eccentricus* and *I. heckeli*) and then a discrete medial row of nodes as in *I turbatus.* A comparable change in morphology appears to be present in the group of morphotypes generally assigned to *I. sagittalis* in Eurasia. This post-extinction radiation coincides with the lower portions [low-stand systems tract (LST) and lower transgressive systems tract (TST)] of a major composite sequence resulting from eustatic events, which can be used as a secondary means to recognize the lowermost Kasimovian in the absence of precise biostratigraphic control (see discussion in Rosscoe & Barrick, 2013). If the GSSP is placed at a low point in the composite sequence, then the base of the sequence will coincide closely with the base of the traditional Kasimovian. For this reason, Rosscoe & Barrick suggested that using *I. heckeli,* the precursor species to *I. turbatus*, might be more appropriate. In this case, moreover, the stage base is accordingly brought closer to that of the traditional definition of the Kasimovian. *Idiognathodus heckeli*

is also present in the Naqing section (discussed below) in Guizhou Province of South China, which would allow that section to serve as the GSSP for the base of the Kasimovian.

Progress in South China

The morphological transition discussed above also occurs in the condensed, deep-water (comprises limestone slope turbidites) Naqing (Nashui) section of southern Guizhou province in South China. A complete description of the Naqing faunas is in preparation by Qi Yuping & his colleagues. One could easily use the first occurrence of *Idiognathodus turbatus* in the Naqing section to position the GSSP of the base of the Kasimovian, which would allow detailed correlation of the boundary from South China into the well-defined cyclothems of North America. For that reason, based on data from the Naqing section, Qi *et al.* (2013) recently concluded that the species in the lineage leading to *I. turbatus* show the greatest potential to serve as the biostratigraphic marker for the Moscovian-Kasimovian stage boundary. The documentation of this lineage in the limestone-dominant Naqing section, which appears to lack substantial breaks resulting from either erosion or nondeposition, makes it a good potential candidate for the GSSP at the base of the Kasimovian.

As a general circumstance of conodonts near the Moscovian-Kasimovian boundary, James Barrick stated that although *I. turbatus* has been reported from sections in Eurasia, its presence there is not well documented. Other Eurasian forms that resemble *I. turbatus* and *I. heckeli* have been assigned to the inconsistently used *I. sagittalis*, the first occurrence of which seems to lie near the same level.

KASIMOVIAN-GZHELIAN BOUNDARY

After fixing the base of the Gzhelian Stage by using the first appearance datum of the conodont *Idiognathodus simulator* (Ellison, 1941) *s.s.* in its potential lineage *Idiognathodus eudoraensis* - *I. simulator* (Heckel *et al*., 2008; Villa *et al*., 2009), the task group is directing research toward selecting a suitable section for the GSSP in Russia, China, and the United States of America.

Progress in Russia

In the past years, Alexander Alekseev and his colleagues investigated the Rusavkino quarry section in the Moscow Basin (Alekseev & Goreva, 2007) and the Yablonevyy Ovrag quarry section in the Zhiguli Mountains of Samarskaya Luka, both of which yield good conodont assemblages consisting mainly of *I. simulator*, the marker species for the base of the Gzhelian (Heckel *et al*., 2008). Unfortunately, these sections do not contain the transition from the ancestral *I. eudoraensis* to *I. simulator*; therefore, Alekseev reported they have little potential to become GSSP candidates.

With respect to the conodont succession in the Kasimovian-Gzhelian boundary interval at Usolka (Southern Urals), James Barrick stated that what was reported earlier by Davydov *et al*. (2008) was based on older collections that, to his knowledge, have not been replicated in more recent studies. He thought that until the conodont succession there is reproduced and better documented, the Usolka section cannot be considered as a potential stratotype section. Gusal Sungatullina (Kazan University, Russia) is restudying the conodonts across the boundary within the Usolka section. Alexander Alekseev is strongly expecting the results of her study to be sufficient to propose using the Usolka section as a potential GSSP candidate for the base of the Gzhelian.

Progress in South China

Qi Yuping & James Barrick continue investigation of the Naqing (Nashui) section in southern Guizhou province and consider it to have promise as a potential GSSP candidate. But there is a conodont-poor gap of about 2 m below the first occurrence of *I. simulator* in that section. The *I. simulator* fauna at Naqing is moderately abundant and diverse; consequently, it can at least serve as an important reference section for the boundary. However, the gap and rarity of other fossils are the drawbacks of this section. Moreover, Qi and his colleagues now study other sections (by villages of Narao and Fenting) in Guizhou province and substantial time will be required to find and understand the evolutionary lineage of marker conodonts in these new sections. New conodont samples from the Kasimovian-Gzhelian boundary interval at the above-mentioned three sections are being processed. During 2013, the task group sampled the Kasimovian-Gzhelian boundary level in the Naqing and other sections for stable carbon isotope geochemistry.

Progress in North America

James Barrick sampled thick Pennsylvanian carbonate sections in New Mexico for conodonts, but recovered only a few isolated specimens of *I. simulator*. The North America Midcontinent sections also possess a gap in the *Idiognathodus* succession below the first occurrence of *I. simulator* in the Heebner Shale (Oread cyclothem). *Idiognathodus simulator* was originally described from the Oread cyclothem and Barrick *et al*. (2008) redescribed the species and provided a new diagnosis. The species, however, includes a variety of morphotypes, some of which have been designated as separate species by other authors. Nick Hogancamp (Texas Tech University) has started a detailed study of the *I. simulator* morphotypes in the Oread cyclothem and

reports that at least three major morphotypes are present in these collections. His research will likely provide a more restricted concept of *I. simulator* than the extremely broad one currently in use. Once this work is completed, the working group should have a better defined biostratigraphic marker by which to identify the base of the Gzhelian Stage.

As an overall statement, James Barrick suggested that because of the strongly cyclical nature of most upper Kasimovian to lower Gzhelian sections and the lack of a well-documented species transition leading to *I. simulator*, prospects look poor for a typical GSSP based on the FAD of a species. Thus the working group may consider proposing that the definition for the base of the Gzhelian is the eustatic event during which *I. simulator* appears. In this instance, the eustatic event would be the primary criterion and the FOD of *I. simulator* becomes the biostratigraphic marker by which the eustatic event can be globally identified and correlated. Although the use of the eustatic event has potential, the amount of concrete conodont-based biostratigraphic data is increasing rapidly increasing from several sections.

Work plans Moscovian- Kasimovian boundary

During the 2014 fiscal year, the search will continue for a suitable index within an evolutionary lineage for definition of the base of the Kasimovian. The ongoing biostratigraphic analyses reported on in section 3a above will continue. Until the 2013 fiscal year, the task group had concluded the first appearance datums (FADs) of either *Idiognathodus sagittalis* Kozitskaya, 1978 or *Idiognathodus turbatus* Rosscoe & Barrick, 2009 had good potential as a marker for the base of the Kasimovian (Villa & task group, 2008; Ueno & task group, 2011). Unfortunately, the use of either species would raise the base of the Kasimovian up approximately one substage from the traditional position at the base of the Russian Krevyakinian Substage. Now, a slightly lower level defined by the occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013, which is considered as the direct ancestor of *I. turbatus* is newly proposed as a more appropriate position of the potential base of the Kasimovian. Thus the task- group members are encouraged to expand their target for detailed examination to a slightly wider stratigraphic interval (approximately Krevyakinian-lower Khamovnikian) for the relevant boundary investigation.

The task-group leader hopes a proposal to use the FAD of a conodont in a suitable lineage for boundary definition can be developed in the new fiscal year. After such a proposal is made and voted on, additional taxonomic work and comparison of morphotypes from different regions can be continued.

Activities in southern China

During the last several years, Qi Yuping & James Barrick intensively studied conodonts from the uppermost Moscovian to lower Gzhelian slope carbonates in the Naqing (Nashui) section, southern Guizhou Province (Qi *et al*., 2007; Barrick *et al*., 2010). As a consequence, they considered that the FAD of *Idiognathodus turbatus* was the best potential boundary marker for the base of the Kasimovian. During future studies, however, they will consider the FAD of *Idiognathodus heckeli* as another potential boundary marker. They will continue with intensive studies to provide more detailed information on the conodont succession across the Moscovian-Kasimovian boundary in the Naqing section and several other limestone-dominated, turbiditic sections in the region as a potential GSSP candidate sections. Work on the sequence stratigraphy, sedimentology, stable-isotope geochemistry, and geophysical characteristics of the Moscovian-Kasimovian boundary interval at Naqing is less advanced than the paleontological investigations and needs to be a focus of the team's field work in 2014 and future years.

To place the Naqing section into its sedimentological and paleoenvironmental context and determine the relationship of shallow-water coral, conodont and foraminiferal zones to the deeper-water conodont markers within the Moscovian-Kasimovian transition in south China, the investigation of reference sections including the Zhongdi (Ueno *et al*., 2007), Luokun, and Narao sections will continue. Study of the sections will provide other opportunities to see conodonts and foraminifers spanning the Moscovian-Kasimovian transition in the region. Foraminifers are more abundant and better preserved than at Naqing and it is anticipated that a better correlation between conodonts and foraminifers can be achieved by the study of the other sections.

Activities in Moscow Basin, Russia

The task group will continue to study conodonts from the Stsherbatovka quarry section on the Oka-Tsna Swell of the Ryazan Region, east of the town of Kasimov in the Moscow Basin. In the section, the middle part of the Neverovo Formation (Khamovnikian Substage) contains abundant macrofauna. Conodonts occur as well but are not common and most elements are juveniles of the *Idiognathodus sagittalis-I. turbatus* group. *Idiognathodus sulciferus* was also identified. The Stsherbatovka section, situated about 250 km southeast of the better-known Afanasievo section (Goreva *et al*., 2009) in the Moscow Basin, demonstrates a wider distribution of the marker conodont species for identifying the base of the

Kasimovian. The section is better than the Afanasievo section (neostratotype of Kasimovian and a potential candidate for the GSSP), because it was deposited in somewhat deeper water and elements of the *I. sagittalis-I. turbatus* group are abundant.

Activities in Spain

Spanish members of the task group plan to continue with investigations in most of the regions reported on in the progress report for the 2012 fiscal year. Elisa Villa reported that the University of Oviedo is devoted to the study of the Moscovian-Kasimovian boundary in the Cantabrian Mountains and will continue with intensive research of the Carboniferous limestones outcropping in the Ándara Massif of the Picos de Europa Mountains.

The Spanish team will continue investigating the Vegas de Ándara section (also in the Ándara Massif), where late Moscovian to middle Kasimovian strata are present. Sampling of Podolskian (middle Moscovian) to Khamovnikian beds in the Vegas de Ándara and the Castillo de Grajal sections are being undertaken to analyze the succession of the conodont faunas (J. Sanz & S. Blanco, in progress). These studies include the systematics of *I. sagittalis* collected from the base of the Khamovnikian Substage and their relationship with much scarcer *I. turbatus* and *I. swadei*.

Work plans Kasimovian-Gzhelian boundary

Since 2007, when the task group voted in favor of using the first appearance of the conodont *Idiognathodus simulator* (Ellison, 1941) in the lineage *Idiognathodus eudoraensis* - *I. simulator* as the boundary-defining event (Heckel *et al*., 2008), the search for a suitable section for the GSSP has been the task-group's main objective. The event level is consistent with both the working ammonoid definition of the boundary and with the first appearance of a cotype of the fusulinid *Rauserites rossicus* in the Moscow region.

Activities in Russia

So far, only the Usolka section in the southern Ural Mountains of Russia has been proposed as a candidate section for the GSSP at the base of the Gzhelian (Chernykh *et al.,* 2006; Davydov *et al*., 2008). The Usolka section requires substantial new lithostratigraphic, sedimentologic and conodont-based biostratigraphic work before it can be considered as a candidate section but such work is progressing. Gusal Sungatullina (Kazan University) will continue to investigate the conodonts from Usolka and Alexander Alekseev anticipates her results will permit the Usolka section to be considered as a GSSP candidate for the base of the Gzhelian.

Activities in China

Yuping Qi & colleagues will continue their intensive investigation across the proposed Kasimovian-Gzhelian boundary level in the Naqing section (Wang & Qi, 2003) in Guizhou Province, south China but will continue to investigate other sections in the region as well. Sequence stratigraphic, sedimentologic, geophysical and geochemical analysis of the sections at the appropriate level is required. During 2013, the task group sampled the Kasimovian-Gzhelian boundary level in the Naqing section for stable carbon isotope geochemistry and the processing is underway.

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NEW MICROFACIES AND FOSSIL RECORDS (AMMONOIDS, CONODONTS, FORAMINIFERS) FROM THE VISÉAN-SERPUKHOVIAN BOUNDARY BEDS IN THE VERKHNYAYA KARDAILOVKA SECTION

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Introduction

In 2013 several members of the Viséan-Serpukhovian Boundary Task Group (B.C. Richards, A.S. Alekseev, E.I. Kulagina, Yu.A. Gatovsky, S.V. Nikolaeva and others) continued examination of fossils and microfacies using samples collected in 2011–2012 from the Viséan-Serpukhovian boundary beds near the village of Verkhnyaya Kardailovka on the right bank of the Ural River in the Baimak District of Bashkortostan, Russia. That section has been proposed as a GSSP candidate for the base of the Serpukhovian Stage (Pazukhin *et al*., 2010 and others) and previously covered intervals in the boundary interval have been excavated and measured to make it a more suitable GSSP candidate section.

Over the past ten years, the boundary definition for the base of the Serpukhovian Stage has been extensively debated. The traditional markers (ammonoids *Cravenoceras* and/or *Edmooroceras pseudocoronula* – see historical review in Nikolaeva and Kullmann, 2003) cannot be used as global boundary indicators because of the scarcity of sections with ammonoids. Therefore, researchers from various countries have searched for a suitable boundary index near the traditional base of the type Serpukhovian, situated in the Zaborie quarry of the Moscow Basin (Kabanov *et al*., 2003). It was suggested that the boundary could be placed at the level of the FAD of the conodont *Lochriea ziegleri* (Skompski *et al*., 1995; Nikolaeva *et al*., 2002, 2005; Cozar *et al*., 2008), which was thought to be close to the traditional base of the Serpukhovian. The Verkhnyaya Kardailovka section in the South Urals is considered to be one of the best candidate sections, because of multiple ammonoid occurrences throughout the Upper Viséan and Serpukhovian, the good conodont and foraminiferal record, and the absence of evidence for significant redeposition.

During the last several years, four main trenches (labelled from A to D) were excavated at the locality (Richards *et al*., in press). For this study, we focused on the boundary beds exposed in Trench B, where the boundary based on the FAD of *L. ziegleri* is located within the interval between 19.00 and 19.95 m above the base of the section. Trench B was excavated with a backhoe across the area occupied by trenches 1 to 3 of Nikolaeva *et al*. (2009b). The one-metre-thick interval is described below in detail, including a summary of records of fossils and microfacies. Ammonoids from the interval have been systematically studied (Nikolaeva, 2013), whereas the conodonts and foraminifers are figured here for the first time. The boundary interval immediately overlies limestone interlayered with volcanic ash, allowing radiometric U-Pb dating and sedimentary depositional analysis (Schmitz & Davydov, 2012; Richards *et al*., in press).

Ammonoids

The ammonoids discussed here were collected from 18.50–20.10 m above the base of the Verkhnyaya Kardailovka section (Bed 21 of Nikolaeva *et al*. 2009b; Nikolaeva, 2013) and characterize the *Hypergoniatites-Ferganoceras* Genozone that was first established in the Urals by Ruzhencev & Bogoslovskaya (1971) mainly based on the section of the Dombar Hills, which was re-examined by several members of our team (Nikolaeva *et al*., 2009a). The interval is underlain by beds with ammonoids of the *Goniatites* Zone (Samples 16.50, 16.64 (16.50 and 16.64 m) (Nikolaeva, 2013) and overlain by beds with ammonoids of the *Uralopronorites-Cravenoceras* Genozone (Ruzhencev and Bogoslovskaya, 1971; Nikolaeva *et al*., 2009b; Nikolaeva, 2013). Ammonoids from Samples 015/5 (17.2–17.3 m), 015/2 (17.7–18.0 m), and 015 (18.4–18.52 m) were previously recorded by Nikolaeva *et al*. (2009b), Pazukhin *et al*. (2010), and Nikolaeva and

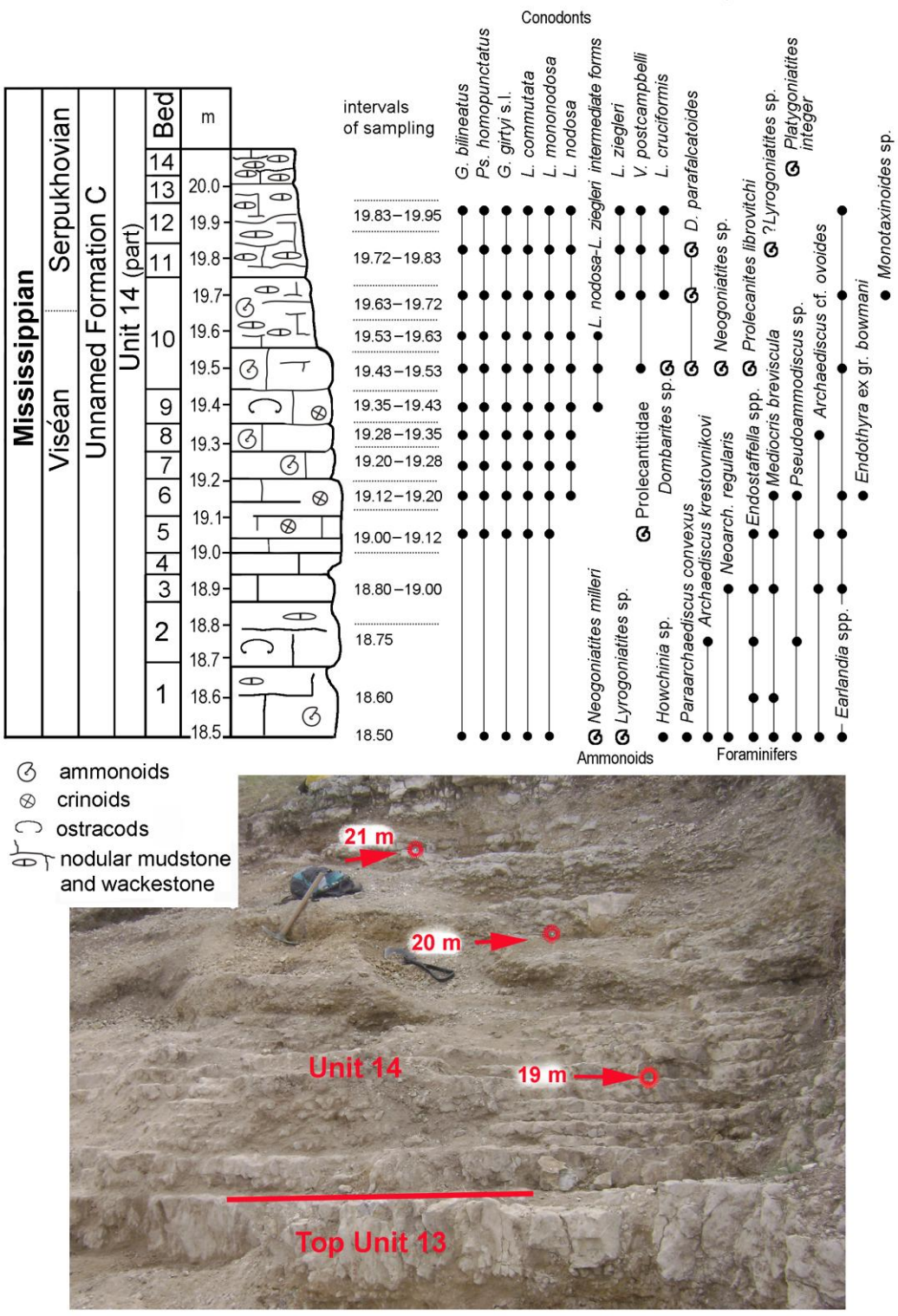


Fig. 1. Fossil records in the interval 19.00–19.95 m in Trench B in the Verkhnyaya Kardailovka Section. The photograph shows the boundary interval excavated in 2011–2012 and levels marked by the aluminium pins (19 m, 20 m, and 21 m).

Konovalova (2011). Other ammonoid occurrences (at levels 19.0, 19.20, 19.44, 19.50, 19.55–19.65, 19.72–19.83. and 20.30 m) are new (Fig. 1). Juvenile ammonoid shells are found throughout the interval in residues from the conodont samples, and are also abundant in the thin sections, especially in the interval 19.44–19.72 m. The ammonoids are found in the rock matrix (level 19.44) and within intraclasts (levels 19.65, 19.72). Like at the Dombar Hills, the *Hypergoniatites-Ferganoceras* Genozone spans the Viséan-Serpukhovian boundary because the base of the Serpukhovian as defined by the first

appearance of the conodont *Lochriea ziegleri,* lies within it (Nikolaeva *et al*., 2009a, 2009b; Pazukhin *et al*., 2010). The ammonoid assemblage contains *Prolecanites librovitchi* Ruzhencev, *Dombarites parafalcatoides* Ruzhencev and Bogoslovskaya, *Neogoniatites milleri* Ruzhencev and Bogoslovskaya, and *Lyrogoniatites* sp. It is overlain by beds with *Platygoniatites integer* Nikolaeva and *Dombarites* sp. (Fig. 2). Compared to the synchronous Late Viséan ammonoid assemblage in the Dombar section (Ruzhencev & Bogoslovskaya, 1971; Nikolaeva *et al*., 2009a) the assemblage is impoverished, but it is possible to recognize the *Dombarites parafalcatoides* Zone, established by Nikolaeva (2013), which corresponds to either the *P. cloudi* Zone or the *Dombarigloria miranda* Zone of the Dombar Hills. It is also possible that the interval containing the *D. parafalcatoides* assemblage in the Verkhnyaya Kardailovka section corresponds to both these zones. The *Hypergoniatites–Ferganoceras* Genozone is recognized in the South and Central Urals (Librovitch, 1940; Pitinova, 1974; Nikolaeva, 1994, 1995), where it contains the key genera and species of the Dombar assemblage. It is also found in the Novaya Zemlya Archipelago (Kuzina & Yatskov, 1988). Outside the Urals and Tien Shan Mountains, the correlation of the genozone is complicated and based mainly on the presence of the *Hypergoniatites, Ferganoceras*, and *Neogoniatites*. Ammonoids from this genozone are similar in age to representatives from assemblages G-3, G-4, and G-5 of the Gara el Itima section in the Anti-Atlas Mountains of Morocco (Korn *et al*., 1999; Klug *et al*., 2006), the Cantabrian Mountains in Spain (Wagner-Gentis, 1980), and Xinjiang province in China (Ruan, 1984; Liang & Wang, 1991). In the Subvariscan Basin (British Isles, Germany), correlation of this genozone is uncertain because neither index genera nor species have been found.

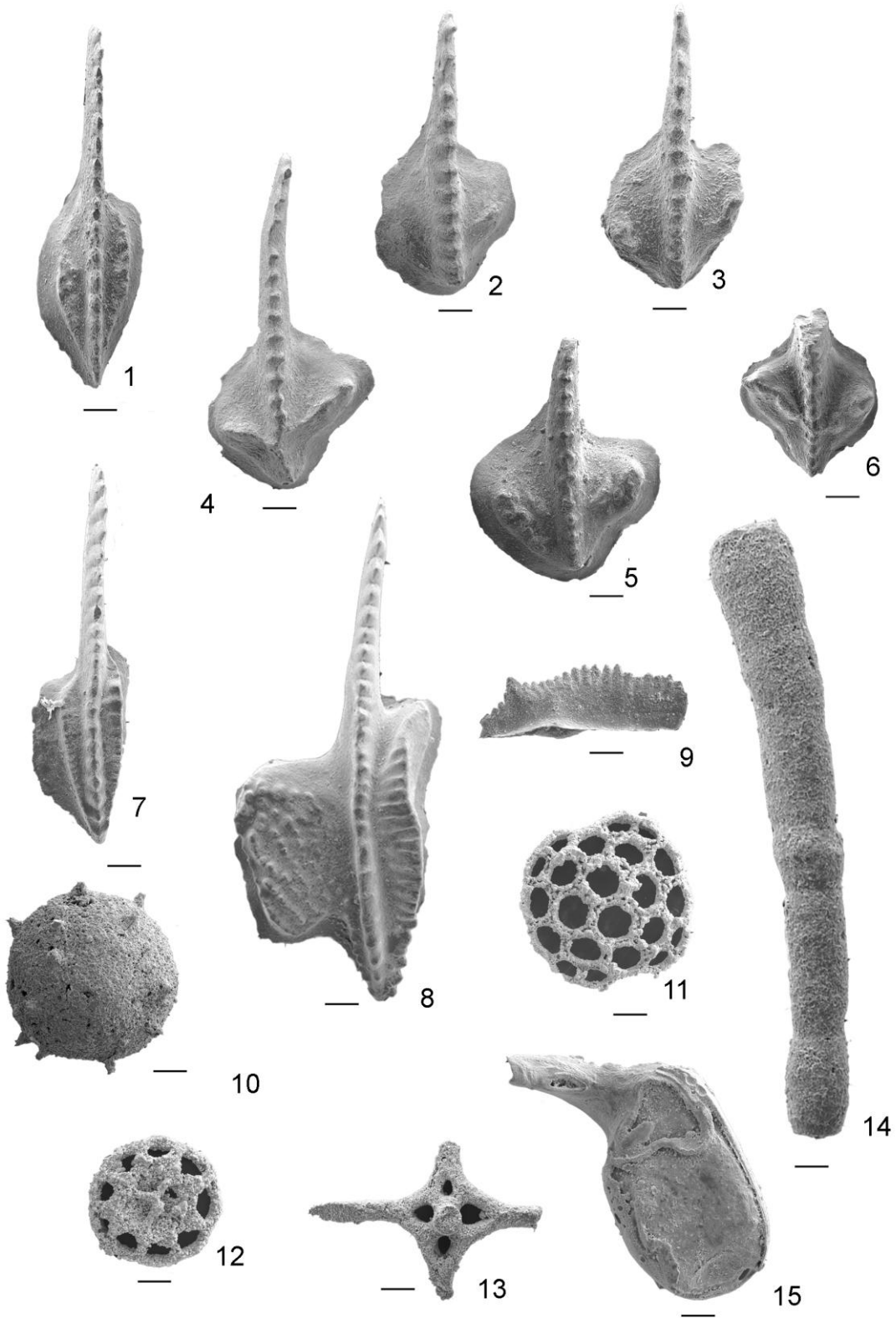
Fig. 2. *Platygoniatites integer* Nikolaeva. Trench B, level 20.30 m, 0.7 m below sample no. 2722; Serpukhovian; shell diameter 53.3 mm.

Conodonts

The boundary beds between 19.00 and 19.95 m were sampled for conodonts at successive intervals that were approximately 10 cm thick. The average weight of each sample was around 30 kg, but not all material has been processed. Conodont elements are abundant in the samples, with the conodont number commonly higher than 100 specimens/kg. Among them, P elements of *Lochriea* are the most abundant, with more than 800 elements of this genus available from the sample from interval 19.12–19.20 m, although many of them are juveniles. *Gnathodus bilineatus* and *G. girtyi* groups are subordinate. We observed no signs of sorting of conodont elements by size, although juveniles were particularly abundant in the lower half of the boundary interval. Among the thousands of elements recovered, no examples of the shallow-water *Cavusgnathus* and *Synclydognathus* were found. This suggests a fairly deep water environment with slow sedimentation.

The interval studied includes the top part of the *L. mononodosa* Zone (19.00–19.12 m), *L. nodosa* Zone (19.12–19.63 m), and *L. ziegleri* Zone (19.63–19.95 m). Most importantly, the interval shows the first appearance of *Lochriea ziegleri* in the evolutionary lineage *Lochriea nodosa–Lochriea ziegleri* between 19.63–19.72 m (Plate 1). Elements that are between *L. nodosa* and *L. ziegleri* have been observed in samples collected between 19.35 and 19.43 m. The platform ornamentation of *Lochriea* elements is highly variable and several new species will need to be described in the future to accommodate all the diversity of forms. The assemblage also includes *Pseudognathodus homopunctatus*, *L. mononodosa*, *Vogelgnathus postcampbelli*, and *Gnathodus girtyi* s.l. (see the distribution of conodonts in Fig. 1).

Fig. 3. (next page) Conodonts and other microfossils from the Viséan-Serpukhovian boundary beds in the Verkhnyaya Kardailovka section. The specimen on photograph 6 is from Trench C, other specimens are from Trench B. In all cases magnification is x 60: (1) *Pseudognathodus homopunctatus* (Ziegler), Trench B, sample VK3/19.00–19.12; (2) *Lochriea mononodosa*, Trench B, sample VK3/19.00–19.12; 3. *Lochriea nodosa* (Bischoff), Trench B, sample VK3/19.12–19.20; (4) *Lochriea cruciformis* (Clarke), Trench B, sample VK3/19.72–19.83; (5) *Lochriea ziegleri* Nemirovskaya et al., Trench B, sample VK3/19.63–19.72; (6) *Lochriea ziegleri*. Specimen 036, primitive morphotype with a few small-sized and low nodes. Trench C, Sample 012/1; (7) *Gnathodus girtyi* Hass s. l., Trench B, sample VK3/19.20–19.28; (8) *Gnathodus bilineatus bilineatus* (Roundy), Trench B, sample VK3/19.63–19.72; (9) *Vogelgnathus postcampbelli* (Austin & Husri), Trench B, sample VK3/19.63–19.72; (10) *Thurammina papillata* Brady, Trench B, sample VK3/19.12–19.20; (11–13) Holothurian sclerites, Trench B, sample VK3/19.72–19.83; (14) Agglutinated foraminiferan, Trench B, sample VK3/1910–19.20; (15) Phyllocarid mandible, Trench B, sample VK3/19.63–19.72.



Foraminifers

In Trench B, foraminifers were studied in the interval 18.0–19.95 m from the following levels: 18 m, 18.5 m, 18.75 m, 19.3 (coll. by E.I. Kulagina, 2011–2012); 19.00–19.12; 19.12–19.20, 19.43-19.53, 19.63–19.72, 19.72–19.83 m (coll. by A.S. Alekseev, 2012).

Foraminifers in this interval are represented by an impoverished assemblage of the *Endostaffella-Mediocris* biofacies. The shells are very small, mainly

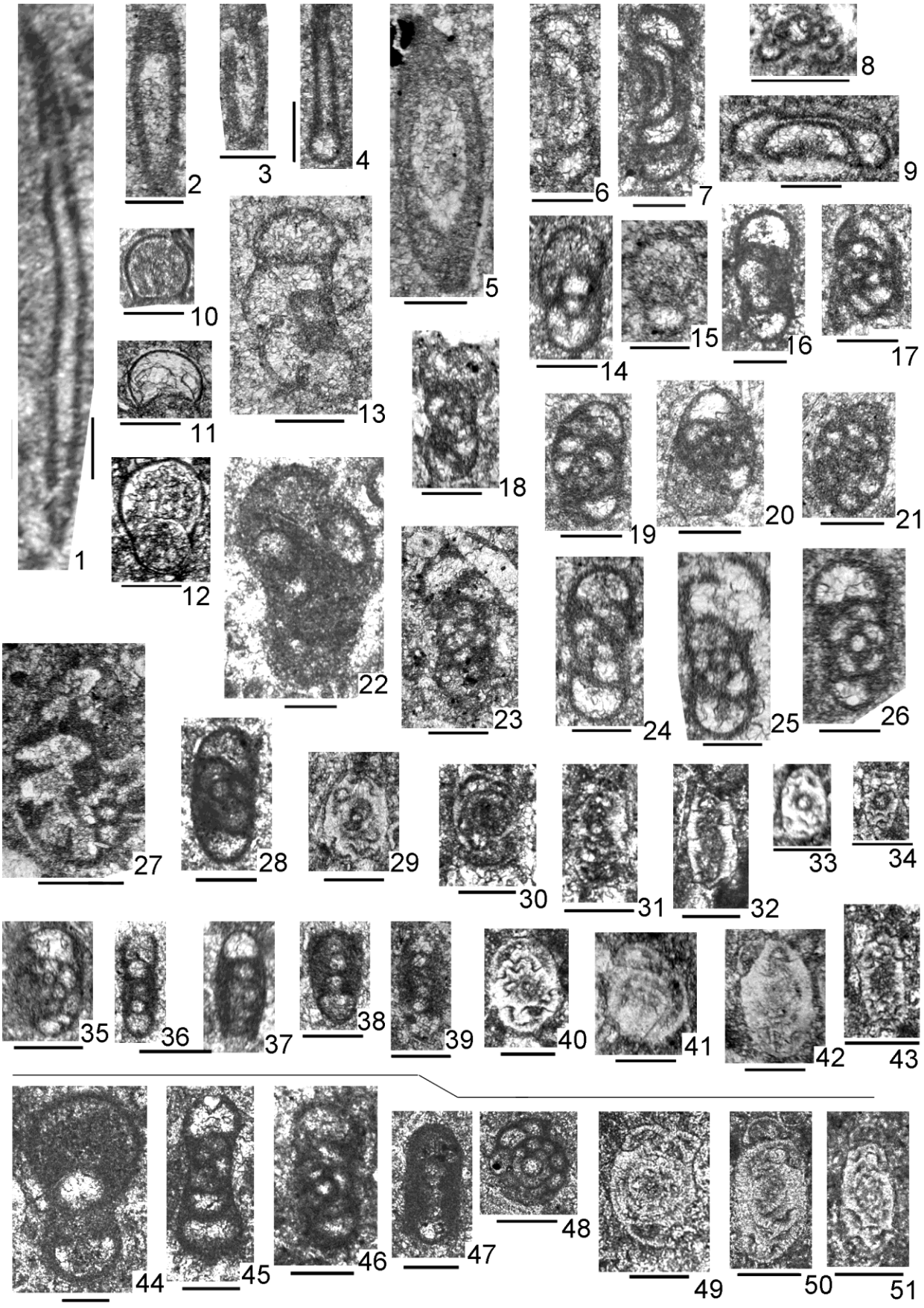


Fig. 4. Foraminifers from the Verkhnyaya Kardailovka Section, South Urals. All except specially indicated are from the Upper Viséan. The specimen on photograph 23 is from Trench C, other specimens are from Trench B. The line separates samples collected in 2011–1012 (above the line) and those collected before 2011 (below the

line). Scale bar = 0.1 mm. (1, 2, 3) *Earlandia* sp.: (1) interval 19.63–19.72 m, thin section 2, specimen no. 0094, Serpukhovian; (2) interval 19.0–19.12 m, thin section 2, specimen no. 0015; (3) interval 19.43–19.53 m, thin section 8. specimen no. 0087; (4) *Earlandia elegans* (Rauser-Chernousova & Reitlinger); interval 19.63–19.72 m, thin section 7, specimen no. 0097, Serpukhovian; (5) *Earlandia vulgaris* (Rauser-Chernousova & Reitlinger); interval 19.0–19.12 m, thin section 7, specimen no. 0025; (6, 7) *Pseudoammodiscus* sp.: (6) interval 19.1–19.20 m, thin section 2, specimen no. 0044; (7) 18.75 m, thin section 1, specimen no. 121/1202; (8) *Howchinia* sp.; 18.5 m, thin section 1, specimen no. 121/1203; (9) *Monotaxinoides* sp.; interval 19.63–19.72 m, thin section 6, specimen no. 0096, Serpukhovian; (10) *Eotuberitina* sp.; interval 19.0–19.1 m, thin section 1, specimen no. 5357; (11) *Eotuberitina* aff. *reitlingerae* Miklukho-Maclay; interval 19.43–19.53 m, thin section 8; specimen no. 0089; (12) *Bituberitina* sp.; interval 19.12–19.20 m, thin section 7, specimen no. 002; (13) *Rectoendothyra* sp.; interval 19.12–19.20 m, thin section10, specimen no. 0038; (14–16) *Endothyra* spp.: (14) interval 19.0–19.12 m, thin section 2, specimen no. 0009; (15) interval 19.0–19.12 m, thin section1, specimen no. 5362, (16) sample 18.75, thin section1, specimen no. 121/1204; (17, 19–21) *Endostaffella asymmetrica* Rosovskaya; (17) interval 19.12–19.20 m, thin section 3, specimen no. 0045; (19) interval 19.12–19.20 m, thin section 1, specimen no. 0043; (20) interval 19.12–19.20 m, thin section 3, specimen no. 0045; (21) interval 19.0–19.12 m, thin section 8. specimen no. 0029; (18, 23–25) *Endostaffella pauperis* (Durkina) [= *E. delicata* Rosovskaya, 1963 as identified by Ginkel 2010]: (18) 19.0–19.12 m, thin section 7, specimen no. 0027; (23) interval 19.5–19.58 thin section 1, Trench C, specimen no. 121/1197; (24) interval 19.0–19.12 m, thin section 1, specimen no. 5364; (25) interval 19.0–19.12 m, thin section 4, specimen no. 0016; (22) *Endothyra* sp. Interval 18.75, thin section1, specimen no. 121/1206; (26) *Endostaffella* aff. *parva* (Miller, 1879); interval 19.0–19.12 m, thin section 7, specimen no. 0026; (27) ?*Haplophragmella* (*Corrigotubella*) Ganelina; interval 19.00–19.12 m, thin section 7, specimen no. 0022; (28) *Endostaffella* aff. *parva* (Miller, 1879); (29, 30) *Paraarchaediscus* sp.: (29) interval 19.12–19.20 m, thin section 1, specimen no. 0041; (30) Sample 19.30 m, thin section1, specimen no. 121/1205; (31–32) *Archaediscus* ex gr. *krestovnikovi* Rauser-Chernousova; both from the level of 18.5 m, thin section 1, specimens no. 121/1210 and 121/1209 respectively; (33, 34) *Asteroarchaediscus* sp.: (33) interval 19.00–19.12 m, thin section 4, specimen no. 0017; (34) 18.5 m, specimen no. 121/1218; (35–39) *Mediocris breviscula* Ganelina: (35) interval 19.0–19.12 m, thin section 2, specimen no. 0013; (36) interval 19.12–19.20 m, thin section 1, specimen no. 0042; (37) interval 19.0–19.12 m, thin section 8. specimen no. 0003; (38) interval 19.12–19.2 m, thin section 1, specimen no. 0041a; (39) interval 19.53–19.63, thin section1, specimen no. 121/1201; (40, 41, 42) *Archaediscus* cf. *ovoides* Rauser-Chernousova: (40) Sample 19.30 m, thin section 1, specimen no. 121/1207; (41) interval 19.0–19.12 m, thin section 1, specimen no. 5361; (42) interval 19.0–19.12 m, thin section 9. specimen no. 0034; (43) *Neoarchaediscus regularis* (Suleimanov); 18.50 m, specimen no. 121/1218a; (44–51) collected by V.N. Pazukhin in 2001, Sample 014/1, Trench 3 [= Trench B], interval 18.8–19.0 m; (44) *Endothyra* sp.; thin section 2, specimen no. 121/1211; (45–46) *Endostaffella pauperis* (Durkina): (45) thin section 2 specimen no. 121/1212, (46) thin section 3 specimen no. 121/1213; 47, 48. *Mediocris breviscula* Ganelina: (47) axial section, thin section 5, specimen no. 121/1200; (48) sagittal section, thin section 2, specimen no. 121/1214; (49) *Archaediscus* cf. *ovoides* Rauser-Chernousova, thin section 3, specimen no.121/1215; (50) *Archaediscus* aff. *timanicus* Reitlinger, specimen no.121/1216; 51. *Neoarchaediscus regularis* (Suleimanov), thin section 7, specimen no. 121/1217.

0.15-0.30 mm, whereas the assemblage is dominated by euryfacial species of wide stratigraphic range. The identification to species is difficult because the morphology of shells is not very typical (probably because of the unfavourable environment). The foraminiferal assemblage includes 17 genera, although the number of shells in thin section can occasionally be high (up to 10–15).

In the interval 18.50–19.35 m, below the FAD of the conodont *Lochriea ziegleri*, the foraminiferal assemblage (although generally very impoverished) is more diverse and dominated by *Eotuberitina* aff. *reitlingerae* Miklukho-Maclay, *Earlandia* spp., *Endostaffella asymmetrica* Rosovskaya, *E.* aff. *parva* (Miller), *E. pauperis* (Durkina) (= *delicata* Rosovskaya emend Van Ginkel, 2010) and *Mediocris breviscula*, and also very small-sized archaediscids, occasional *Rectoendothyra* sp., *Endothyra* spp., *Pseudoammodiscus* and *Haplophragmella* species are present (Figure 4). The same interval contained samples collected in 2001, 2002 and 2004 (015–014, Nikolaeva *et al*., 2005), which are now correlated with the level marked by pins. Some of these foraminifers are figured in (Nikolaeva *et al*. 2009b, Fig. 4, photographs 2, 4–6, 9–11 from samples 015/2 (17.8–18 m) and 014/1(18.8–19.0 m). A similar assemblage is recorded from the Viséan-Serpukhovian boundary beds of the Nashui Section. Guizhou province, South China (Groves *et al*., 2012), although the Chinese fauna is more diverse and includes paleotextulariids, tetrataxids and some endothyrids (all long-ranging taxa), which are not found in Verkhnyaya Kardailovka.

In the interval 18.5–19.20 m, the diversity and abundance of foraminifers decreases sharply upward in the section (level 19.35 m), whereas higher in the section (at 19.43–19.63 m) only occasional specimens of one genus, *Earlandia*, are observed (see Fig. 1).

The foraminiferal distribution in the interval 19.35–19.63 in Trench B is somewhat similar to that in the shallow-water succession in the Moscow Basin (Zaborie quarry), where similar

impoverishment is observed in the uppermost Venevian (Bed 2b), and the lowermost Tarussian (Bed 3a-1) (Gibshman, 2003, Plate 2).

Of foraminifers, found in the interval 18.5–19.95 m in Trench B, only *Neoarchaediscus regularis* (Suleimanov, 1948) are important for correlations. *N. regularis* (originally *Archaediscus parvus regularis*) was first described from the Namurian in a borehole within the Ishimbai Region of Bashkortostan. This species is found in the equivalents of the Venevian and Lower Serpukhovian in the South Urals, in the Khudolaz section (Stepanova and Kucheva, 2006), and in the Middle Urals–in the Ladeinyi Log Section (Ponomareva, 2010). It has also been found in the Donets Basin from the Mezhevian Horizon (Upper Viséan C1 vg Zone, Limestones B4-B6), which correlates with the Venevian of the Russian Platform (Vdovenko, 2000). In the Paltau Section, Middle Tien Shan, the foraminiferal *N. regularis–Biseriella parvae* Zone correlates with the conodont *L. cruciformis* Zone, and the upper portion of the ammonoid *Hypergoniatites-Ferganoceras* Zone and the lower part of the *Uralopronorites-Cravenoceras* Genozone (Nigmadzhanov *et al*., 2010).

In the interval 19.63–19.95 m, which corresponds to the Serpukhovian part of the section (after the entry of *L. ziegleri*), we identified *Earlandia* sp., *Earlandia elegans* and *Monotaxinoides* sp.

Other microfossils

The insoluble residues derived from processing the conodont samples contain an abundant and diverse association of microfossils, which could be useful environmental indicators: fragments of crinoidal columnals, fish scales and teeth, holothurian sclerites, tubes of agglutinated foraminifers, rare radiolarians, lingulid brachiopods, moulds of small gastropods, ostracod shells, phyllocarid crustacean mandibulae, and spheroids with spines (foraminifers *Thurammina*, two morphotypes) (Fig. 3).

Microfacies of the Viséan-Serpukhovian boundary beds in the Verkhnyaya Kardailovka Section (Trench B, interval 19.00-19.95 m)

The carbonate microfacies within the boundary interval are described using the lithofacies and environmental terminology of Wilson (1970). Large- (>500–1000 μm) and medium-sized skeletal grains (>100–500 μm) in standard-size thin sections (2.5 x 2.5 cm) were counted manually using a grid overlay and designated as either “many” (>10 grains) or “few” (> 5 grains). The proportion of cement (micrite with microbioclasts) of uncertain systematic affinity, large- and medium-sized bioclasts, and proportion of the matrix and intraclasts (interval 19.72–19.95 m) were also determined. Two microfacies are recognized based on an assemblage of characters (texture and composition of bioclasts and intraclasts) (Fig. 5).

Microfacies 1 (Finely and micro-bioclastic wackestone with inclusions of large bioclasts):

Microfacies 1 is recognized in the intervals 19.00–19.53 and 19.63–19.72 m. It is represented by fine and microbioclastic wackestone with large bioclasts (Plate 1, fig. 1) embedded in microgranular micrite (80–85%) filled with microbioclasts (<100 μm). The micrograins are densely packed and not oriented. Large bioclasts (>500 μm) constitute from 5 to 15% of the rock and are mainly represented by fragments of echinoderm skeletons (crinoid, echinoid, and holothurian sclerites). Some grains are bryozoan fragments and occasionally (19.63–19.72 m) numerous spheres (possibly isolated fragments of dasycladacean algae) (Mamet, 1998) occur. Foraminiferal shells are present, but they are only abundant between 19.00 and 19.12 m. The proportion of large-sized skeletal material varies in different intervals. Thin sections also show cross-sections of trilobite skeletons, and relatively abundant juvenile ammonoid shells ~ 500–1500 μm in diameter.

Medium-sized bioclasts (100–200 μm) constitute up to 10% of the rock. They are represented by small gastropods, echinoderm ossicles, sponge spicules, and very thin walled (<100 μm) ostracod shells. Rod-like structures with a porcelain-like wall (thalli of algae adapted to relatively deep-water and low-light conditions) are observed occasionally. The distribution of medium-sized bioclasts is relatively uniform throughout the interval studied.

The shells of foraminifers, ostracods and juvenile ammonoids are usually intact. Their good state of preservation suggests in situ burial, whereas the heavily worn large-sized echinoderm bioclasts were probably transported to this site.

The distribution of shells of foraminifers and juvenile ammonoids show certain patterns. Thin sections from the intervals of 19.00–19.12 m and 19.12–19.20 m contain occasionally abundant foraminiferal shells of a very small size. Above 19.20 m, the number of foraminifers and their diversity sharply decrease (Fig. 1). Ammonoids show a different distributional pattern. At the base of the metre-thick boundary interval (19.00–19.12 m) their shells are scarce, whereas higher in the section (19.35–19.72 m) the number of juvenile ammonoid shells increases considerably.

The above features suggest a normal-marine outer-shelf (deep undathem of Wilson, 1970) to upper-slope environment in relatively deep-water without features of bacterial-algal micritization.

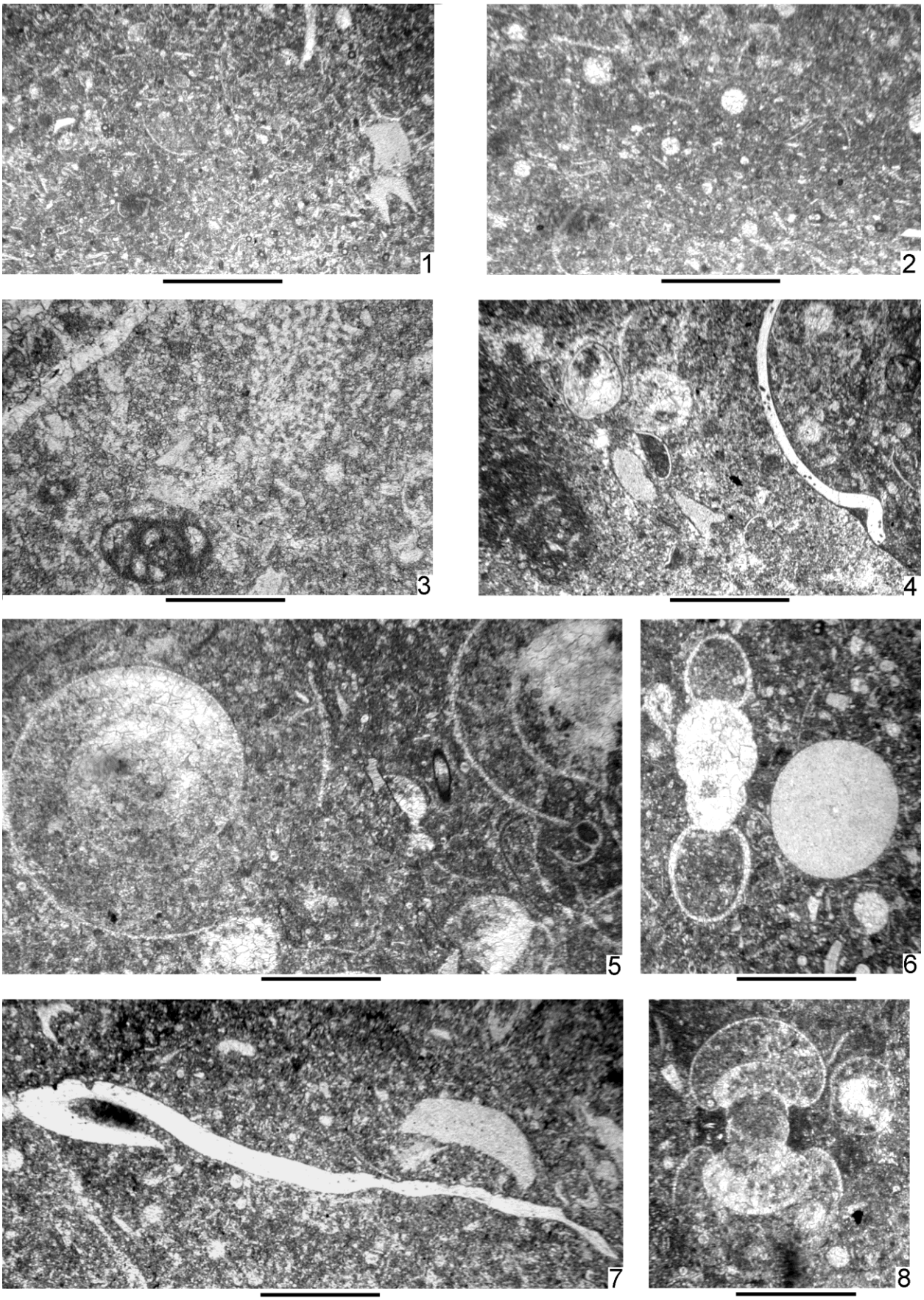


Fig. 5. Microfacies from the Verkhnyaya Kardailovka section. (1–3, 6–8) microfacies 1 (19.00–19.63 m); (5, 4) microfacies 2 (interval 19.72–19.95 m). Scale bar = 0.2 mm: (1) wackestone finely- and microbioclastic with large-sized bioclasts (>500 μm–right half of the thin section) constituting less than 10% of the rock. Cement (80–

85%) is represented by microgranular micrite with microbioclasts embedded in it (< 100 μm). Grains are loosely packed. Photograph 0027, interval 19.00–19.12 m, thin section 1; (2) wackestone with mass accumulation of spheres (10% of the rock). Photograph 0095, interval 19.63–19.72 m, thin section 5; (3) wackestone/packstone with large-size weathered and shattered bioclasts and foraminiferal shell *Endostaffella.* Photograph 0043, interval 19.12–19.20 m, thin section 1; (4) wackestone microbioclastic-intraclastic. Intraclasts (grain on the periphery) form structureless accumulations of a darker appearance contoured by a lighter calcite rim. Photograph 0098. Interval 19.72–19.83 m, thin section 2; (5) mudstone with microbioclasts and ammonoid shell. Photograph 0120, interval 19.83–19.95 m, thin section 10; (6) wackestone with isolated grains of weathered bioclasts (fragment of crinoid ossicles and juvenile ammonoid shell). Photograph 0037, interval 19.00–19.12 m, thin section 9; (7) wackestone with a fragment of a trilobite skeleton. Photograph 0080, interval 19.35–19.43 m, thin section 2; (8) wackestone with abundant shells of juvenile ammonoids. Photograph 0090, interval 19.43–19.53 m, thin section 9.

Microfacies 2 Microbioclastic wackestone with intraclasts:

Microfacies 2 occurs between 19.72 and 19.95 m where it is represented by microbioclastic wackestone with intraclasts. Both the microbioclastic and intraclastic components of this microfacies are closely similar or identical in their skeletal elements.

The most apparent feature of microfacies 2 is the upward change in the composition of cement components. At the top of the interval from 19.83 to 19.95 m, in some thin sections, microbioclastic wackestone is replaced by microbioclastic mudstone. This is accompanied by an increase in the amount of juvenile ammonoid shells and a sharp reduction in, to complete absence of, large-sized echinoderm bioclasts (> 500 μm).

The main (microbioclastic) component of the microfacies is finely and microbioclastic wackestone with densely packed micrograins. Large (> 500 μm) skeletal fragments are rare and are mainly represented by echinoderm debris (crinoids, echinoids). Extremely thin-walled (<100 μm) ostracod shells, isolated spicules and algal fragments are also uncommon. In contrast, juvenile ammonoid shells are present throughout the interval and some thin sections, contain several shells. However, the abundance of foraminiferal shells decreases sharply, with only occasional occurrences of *Earlandia*.

Large, medium-sized and small intraclasts (0.5–2 cm), rounded and rounded-oval with even or wavy margins occupy up to 50% of the area of a thin sections, and are darker than the surrounding matrix. Contact with the matrix shows either a thin layer of bitumen-clay matter, or a rim of calcite microclasts. Intraclasts consist of microbioclastic wackestone. Some thin sections from the uppermost part of the 19.83 to 19.95 m interval show mudstone with scattered micrograins of bioclasts. Interestingly, juvenile ammonoid shells are frequent components of both the main rock matrix, and intraclasts.

Conclusions

The boundary interval in Trench B in the Verkhnyaya Kardailovka section contains the first evolutionary appearance of *L. ziegleri* in the *L. nodosa–L. ziegleri* lineage**.** Conodonts are found in association with many other fossil groups including foraminifers, ammonoids, holothurian ossicles, phyllocarid fragments and corals, which provides high correlation potential with both deep-water and shallow-water successions world-wide. The microfacies suggest essentially continuous deep-water deposition with little reworking or redeposition. The entire section and the boundary interval in particular, have been thoroughly sampled and marked with aluminium pins at one-metre intervals, allowing the precise documentation of sample levels.

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THE VISÉAN - SERPUKHOVIAN BOUNDARY IN THE BIG KARATAU MOUNTAINS (SOUTH KAZAKHSTAN)

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Introduction

The Serpukhovian sections in the Big Karatau Mountains of Kazakhstan (Fig. 1) are well exposed and contain an excellent fossil record; consequently, they can be used as reference sections for the Viséan-Serpukhovian boundary (Zhaimina, 2006). The best-studied boundary successions in the northwestern part of the Big Karatau are in the Zhankurgan, Aktobe, Akuyuk, Zhertansay, and Ushozen sections (Fig. 2). These important sections, however, require comprehensive restudy to more adequately document their lithofacies and biostratigraphy, especially that of the foraminifers and conodonts. The information presented herein documents the preliminary results of that reevaluation.

Finding a suitable index to define the GSSP at the Visean-Serpukhovian boundary and locating a suitable section for that GSSP are two of the principle research objectives of the SCCS (Subcommission on Carboniferous Stratigraphy) Task Group assigned by the International Commission of Stratigraphy (ICS) to establish a GSSP for the Visean-Serpukhovian boundary (Richards *et al.*, 2013). For boundary definition, the task group plans to use the first evolutionary appearance of the conodont *Lochriea ziegleri* Nemirovskaya, Perret & Meischner, 1994 in the lineage *Lochriea nodosa* (Bischoff, 1957) – *Lochriea ziegleri.* Although a potential index for boundary definition has been selected, it has not been voted on by the SCCS for final approval. *L. ziegleri* appears in the Venevian regional Substage of western Russia (Nikolaeva *et al.*, 2009; Pazukhin *et al.*, 2010; Nikolaeva, 2013), which is somewhat below the current base of the Serpukhovian as defined by its lectostratotype section in the Zaborie quarry near the city of Serpukhov in the Moscow Basin, Russia (Kabanov *et al.*, 2012, 2013).

The stratigraphic scheme for the Carboniferous Systems used in Kazakhstan is similar to the General Stratigraphic Scheme adopted for Russia and the countries of the former Soviet Union in 1992, but without the subsequent changes adopted for Russia in 1997. During the 1970s, the Carboniferous scheme was elaborated on in the USSR, and was adopted in 1986 by the Stratigraphic Commission of the USSR. Since then, changes have not been introduced in the scheme as used in Kazakhstan. In 1991, a succession of regional substages was adopted for the Regional Stratigraphic Scheme employed in Kazakhstan but that convention requires revision and the situation has initiated the reexamination of the position of the Viséan-Serpukhovian boundary (Zhaimina, 2002) and other Carboniferous boundaries in Kazakhstan.

Locating the upper boundary of the Viséan Stage in Kazakhstan and elsewhere using foraminifers and many other taxa remains problematic. In the Franco-Belgian Basin, that boundary is drawn at the base of foraminiferal zone Cf7 (Conil *et al.*, 1990), at the base of the ammonoid E1 Zone in the British Isles, and in Russia at the base of the *Neoarchaediscus postrugosus* foraminiferal Zone.

In type area of the Serpukhovian (Moscow Basin), the base of the stage was placed at the base of the Tarusian regional Substage near the appearances of *Neoarchaediscus postrugosus*, and *Janischewskina delicata* (Kulagina *& Gibshman*, 2002) but that position cannot be correlated with deeper-water successions using foraminifers. It was previously thought that the appearances of *N. postrugosus*, *E. donbassicus* and *J. delicata* coincided approximately with the FAD of the conodont *Lochriea ziegleri* (Gibshman *et al.*, 2009) but it was recently shown that *L. ziegleri* appears slightly lower within the underlying Venevian regional Substage (Kabanov *et al.*, 2013); therefore, the task of finding a better foraminiferal marker for the base of the Serpukhovian remains.

Geological background

In the northwestern Big Karatau Mountains, the Viséan-Serpukhovian boundary beds are represented by shallow-water shelf carbonate in the Maydantal Formation, which is dominated by brachiopod limestone (Ushozen and Zhertansay

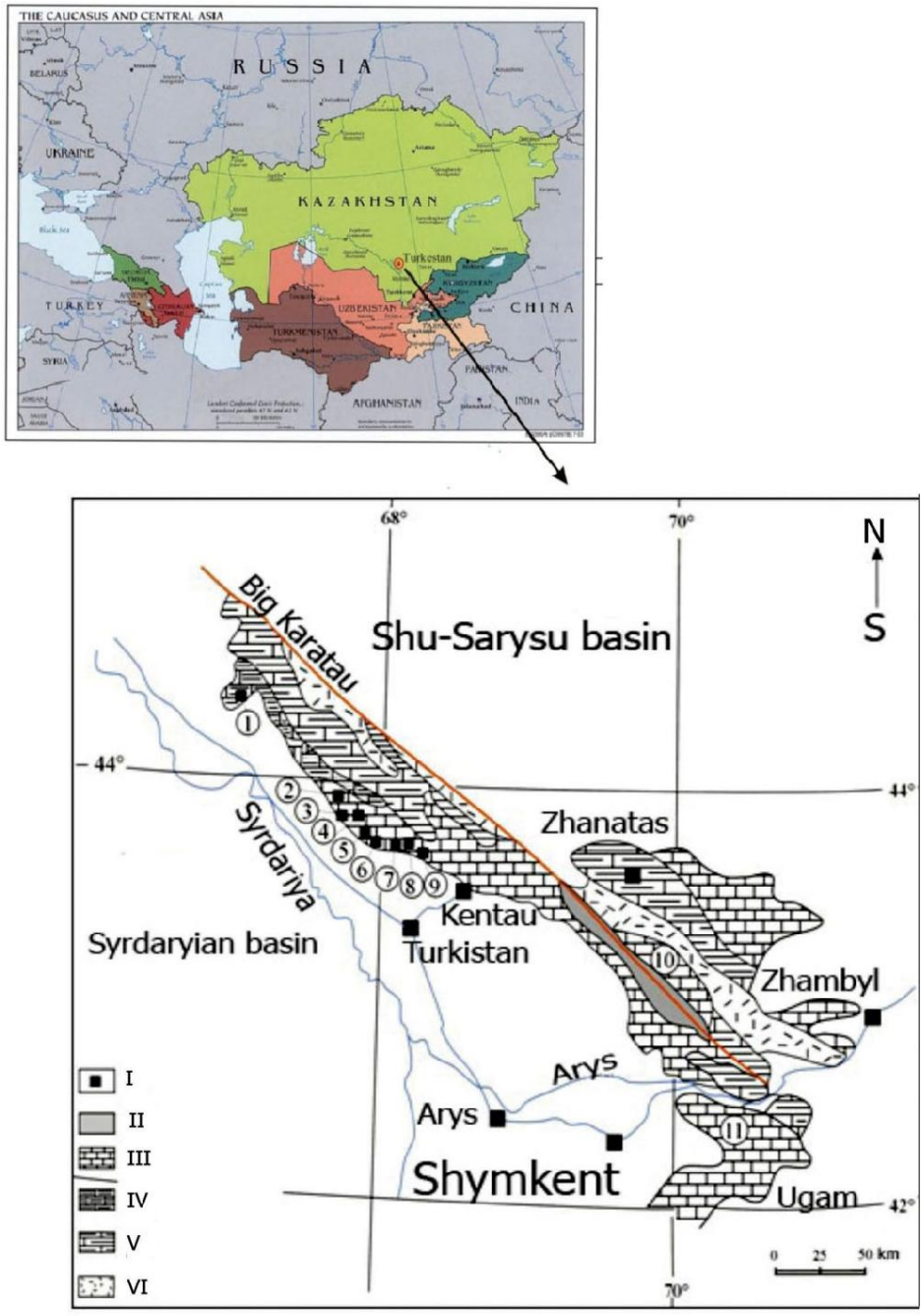

Figure 1: Index map and geological map of study area. Legend for geological map: I. localities for point sampling; II. Jurassic lacustrine deposits; III. Devonian & Carboniferous strata - marine carbonate and siliciclastic deposits; IV. Middle & Upper Devonian strata – marine and continental siliciclastics; V. Cambrian & Ordovician strata – marine and continental siliciclastics; VI. Riphean to Vendian (Proterozoic) – marine and continental siliciclastics. Numbers 1 to 11 are section locations: 1. Karamurun (K); 2. Akujuk (AK); 3. Kainar (KA); 4. Bescharyk (B); 5. Zhertansaj (ZR); 6. Uuschozen (O); 7. Aktobe (AT); 8. Zhankurgan (ZH); 9. Shert (SH); 10. Bajdzhansaj; 11. Ugam.

sections), and by deep-water mixed clastic-carbonate sediments of the Baktysay Formation (Zhanakurgan and Aktobe sections). The deep-water Aktobe section contains carbonate mounds. Deposits of the Baktysay Formation are widespread, strike from southeast to northwest, and are well exposed in the Zhanakurgan, Aktobe, Zhertansay, Ushozen rivers (figs. 1, 2). The Baktysay Formation was deposited from the late Viséan into the early Bashkirian. In the regional Carboniferous stratigraphic scheme of Kazakhstan, the Baktysay lies within the Ishimian, Dalnenskian, Beleutian and Zhertansayian regional Substages and part of the Yagovkinian Substage.

The most interesting and well-studied deep-water sections of the Baktysay Formation are along the estuaries of the Zhanakorgan and Aktobe Rivers, with the Zhanakorgan section being used as a reference section for the Viséan-Serpukhovian boundary interval in Kazakhstan. The Baktysay contains various fossil groups including foraminifers, brachiopods, and crinoids in the shallow-water facies and conodonts, radiolarians and sponges in the deeper water facies (Cook *et al.*, 2002). Conodonts, radiolarians and sponges occur in skeletal lime wackestone. In the Aktobe section, the deep-water carbonates contain buildups consisting

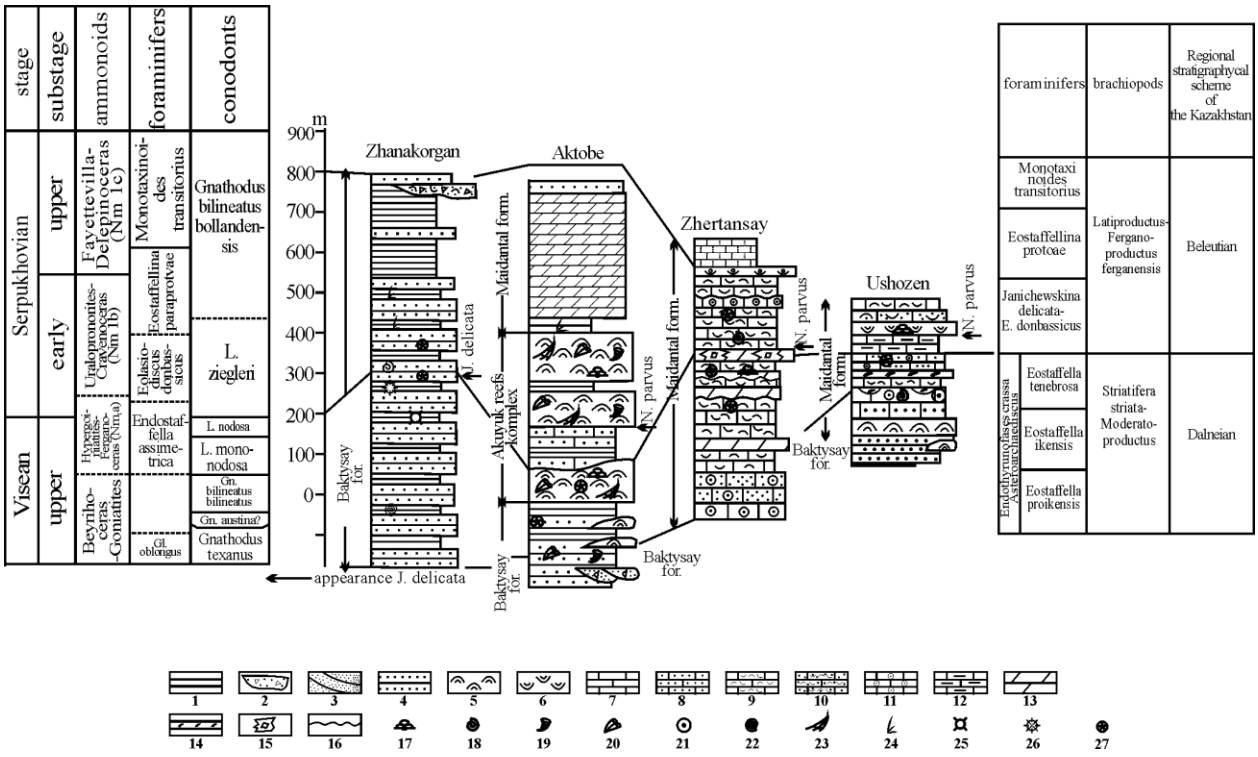

Figure 2: Correlation diagram of deep- and shallow-water Viséan to Serpukhovian deposits of the Big Karatau Mountains. Legend: 1) laminated deep-water limestone, 2) deep-water breccia, 3) sediment-gravity-flow deposits and amalgamated turbidites, 4) medium- and thin-bedded turbidites of reef-flank facies, 5) algal boundstone, 6) algal lime boundstone with the alga *Ivanovia*, 7) lime wackestone and packstone, 8) lime packstone and grainstone, 9) skeletal lime wackestone to packstone, 10) skeletal lime packstone & grainstone, 11) ooid lime grainstone, 12) peloid limestone, 13) bioturbated dolostone, 14) limestone conglomerate, 15) karst breccia, 16) erosion surface, 17) algae, 18) brachiopods, 19) solitary rugose corals, 20) colonial corals, 21) crinoids, 22) ammonoids, 23) bryozoans, 24) conodonts, 25) sponges, 26) radiolarians, 27) foraminifers

of sponges, corals, and bryozoans. The upper Viséan portion of the Baktysay is up to 340 m thick, whereas the Serpukhovian portion is up to 300 m thick. In the Zhanakorgan River section, the Baktysay conformably overlies the lower Viséan Kazanbuzar Formation. The section terminates within the Bashkirian deposits of the Zhertansaian regional Substage.

The Viséan-Serpukhovian boundary is also exposed in the shallow-water Maydantal Formation, which is most complete in the Ushozen and Zhertansay sections, where the boundary beds contain foraminifers, brachiopods, crinoids, and algae. In addition, the lower Serpukhovian beds in the Zhertansay section contain karst breccia, indicating an episode of subaerial exposure. In the regional scheme of Kazakhstan, the Viséan-Serpukhovian boundary coincides with the boundary between the Dalnenskian and Beleutian regional Substages.

The Beleuty section (Zhezkhazgan region), containing the stratotype of the Beleutian regional Substage, has ammonoid occurrences.

Boundary beds: lithology and fossils

Zhanakorgan Section

In the Zhanakorgan River section, deep-sea carbonates of the Baktysai Formation lie between 1,080 and about 1,580 m above the base of the section (figs. 2, 3, 4). The succession comprises lime wackestone interbedded with coarse-grained turbidities. At the base of the Serpukhovian component of the section, lithoclasts in the turbidites contain foraminifers, brachiopods, crinoids, corals, bryozoans and algal fragments. The inter-turbiditic lime wackestone deposits contain radiolarians, fragments of sponge spicules and rare foraminifers (Zhaimina, 1995).

Upper Vséan strata

The Upper Viséan beds in the Zhanakorgan section include lime wackestone interbedded with coarse-grained turbidites. The lower 36 m of the upper Viséan (Fig. 4; 1,080 m to 1,116 m) is dominated by lime grainstone and packstone turbidites containing brachiopods, crinoids, algae and foraminifers with the algae and foraminifers increasing in abundance upward in the succession. The grainstone in samples 11413 and 11414 (Fig. 4)

Figure 3: Photograph showing deep-water limestone of Baktysai Formation in Zhanakorgan section along Zhanakorgan River.

contain the foraminifers *Endothyra similis* (Rauser-Chernousova & Reitlinger, 1936), *E. pauciseptata* (Rauser-Chernousova, 1948), many Omphalotis (*O. omphalota* Rauser-Chernousova & Reitlinger, 1940, *O. involuta* (Brazhnikova, 1967), *Pojarkovella* sp., *Bradyina rotula* (Eichwald, 1860), *Archaediscus chernoussovensis* (Mamet, 1976), *Asteroarchaediscus baschkiricus* (Krestovnikov & Theodorovich, 1936), *Asteroarchaediscus* sp., *Tetrataxis quasiconica* (Brazhnikova, 1967), *Tetrataxis paraminima* (Vissarionova, 1948) and algae *Shartymophycus fusus* (Kulik, 1973).

The overlying 30-metre-thick interval/unit from 1,116 to 1,146 m (Fig. 4) is dominated by lime wackestone but contains a bed of lime grainstone in its basal portion. Samples 11415 to 11416 from the lime grainstone contain the foraminifers: *Eotuberitina* sp., *Eoendothyranopsis* sp., *Mediocris mediocris* (Vissarionova, 1948). The intervening lime wackestone contains sponge spicules and, less commonly, algae.

The 47-metre-thick package of strata between 1,146 and 1,193 m consists of lime wackestone with sponge spicules in its lower part, whereas lime grainstone occurs higher in the section. The samples from the lime grainstone (Fig. 4, numbers 11417 to 11418) contain remains of algae and foraminifers: *Diplosphaerina* sp., *Eoendothyranopsis* sp., *Globoendothyra* sp., *Omphalotis* sp., *Endostaffella* sp., *Howchinia gibba* (Möeller, 1880), *Forschia* sp., and *Quasiammodiscus buskensis* (Brazhnikova, 1967).

The 188-metre-thick interval between 1,193 and 1,381 m (Fig. 4) comprises lime wackestone interbedded with lime grainstone beds, with the latter being dominant. The upper part of the interval contains chert nodules. Grainstone samples (numbers 11419 to 11428) contain the foraminifers *Tolypammina?* sp., *Endothyranopsis compressa* (Rauser-Chernousova & Reitlinger, 1940), *E. crassa* (Brady, 1876), *Eoendothyranopsis* sp., *E. mediocriformis* (Solovjeva, 1967), *Omphalotis cf. infreguentis* (Schlykova, 1951), *O.* aff. *samarica* (Rauser-Chernousova, 1948), *Globoendothyra globula* (Eichwald, 1860), *Pojarkovella nibelis* (Durkina, 1959), *Ninella* sp., *Eostaffella* cf. *parastruvei* (Rauser-Chernousova, 1948), *Eostaffella mosguensis* (Vissarionova, 1948), *Mediocris breviscula* (Ganelina, 1956), *Janischewskina* sp., *Archaediscus pauxillus* (Schlykova, 1951), *Archaediscus* sp., and *Tetrataxis* sp.

Within the interval between 1,193 and 1,381 m, sample numbers 11424 and 11425 contain the conodonts *Gnathodus girtyi girtyi* Hass, 1953. Higher in the same interval, samples 11425 and 11426 contain *Gnathodus bilineatus* (Roundy, 1926) and *Lochriea commutata* (Branson & Mehl, 1941).

Sample numbers 11429 and 11430 from the overlying 44 metres of strata (Fig. 4, interval between 1,381 and 1,425 m) contained the conodonts *Lochriea mononodosa* (Rhodes, Austin & Druce, 1969) and *Lochriea nodosa* (Bischoff, 1957). The deposits in the interval comprise lime wackestone with cherty nodules and sponge spicules.

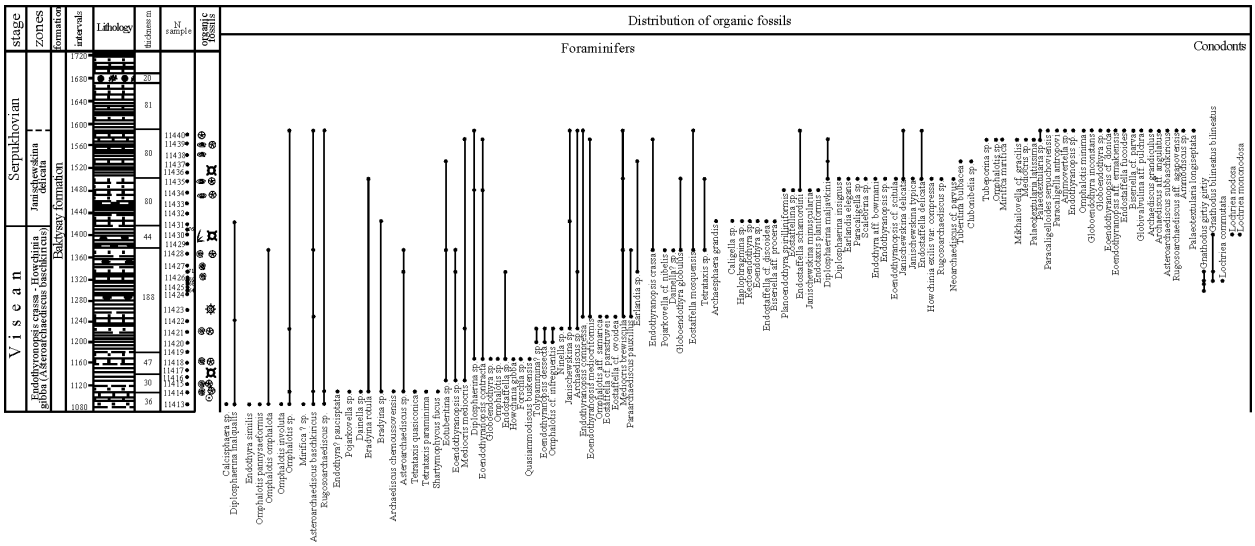

Figure 4: Stratigraphic column of Zhanakorgan section showing rock types and distribution of foraminifera and conodonts across the Viséan-Serpukhovian boundary. See Figure 2 for legend.

Serpukhovian strata

The lower 80 m of strata in the Serpukhovian portion of the section (Fig. 4, 1,425 to 1,505 m) comprise lime grainstone interbedded with lime wackestone (samples 11431 to 11435). In the upper part of the interval, the grainstone contains algae and foraminifera: *Archaesphaera grandis* (Lipina, 1955), *Diplosphaerina maljavkini* (Mikhailov, 1939), *D. insignis* (Conil & Lys, 1968), *Calcisphaera* sp., *Haplophragmina* sp., *Earlandia elegans* (Rauser-Chernousova & Reitlinger, 1940), *Scalebrina* sp., *Endothyra* aff. *bowmani* (Phillips, 1846), *Rectoendothyra* sp., *Endothyra* sp., *Planoendothyra* sp., *Eoendothyranopsis* sp., *Endostaffella* cf. *discoidea* (Girty, 1915), *E. schamordini* (Rauser-Chernousova, 1948), *E. delicata* (Rosovskaja, 1963), *Eostaffellina?* sp., *Biseriella* aff. *procera* (Postojalko, 1990), *Janischewskina minuscularia* (Ganelina,1956), *Janischewskina delicata* (Malakhova, 1956), *Janischewskina typica* (Mikhailov, 1935), *Howchinia exilis* var. *compressa* (Brazhnikova, 1967), *Endotaxis planiformis* (Brazhnikova, 1967), *Neoarchaediscus* cf. *parvus* (Rauser-Chernousova, 1948), and *Rugosoarchaediscus* sp.

The overlying 80 m of Serpukhovian strata (Fig. 4, interval 1,505 to 1,585 m) includes lime wackestone interbedded with lime grainstone. The wackestone contains sponge spicules, whereas the grainstone contains algae and foraminifers. In addition to the previously listed taxa, samples 11436 to 11440 include *Tuberitina bulbacea* (Galloway & Harlton, 1928), *Tubeporina* sp., *Paracaligelloides serpuchoviensis* (Brazhnikova, 1983), *Ammovertella* sp., *Eoendothyranopsis* sp., *E.* cf. *donica* (Brazhnikova & Rostovzeva, 1967), *Mirifica mirifica* (Rauser-Chernousova, 1948), *Omphalotis minima* (Rauser-Chernousova & Reitlinger, 1940), *O.* sp., *Globoendothyra inconstans* (Grozdilova & Lebedeva, 1950), *Globoendothyra* sp., *Mikhailovella* cf. *gracilis* (Ganelina, 1956), *Endostaffella fucoides* (Rosovskaja, 1963), *Biseriella* cf. *parva* (N. Tchernysheva, 1948a) , *Globivalvulina* aff. *pulchra* (Reitlinger, 1950), *Archaediscus grandiculus* (Schlykova, 1950), *A.* aff. *angulatus* (Sosnina in Grozdilova, 1953), *Asteroarchaediscus subbaschkiricus* (Reitlinger, 1949), *Rugosoarchaediscus* aff. *agapovensis* (Ivanova, 1970), *Ammodiscus* sp., *Palaeotextularia longiseptata* (Lipina, 1948), and *P. latissima* (Brazhnikova, 1967).

Near the upper part of the section (about 1,665 to 1,685 m) a conspicuous 20-metre-thick interval of bryozoan-crinoid lime packstone crops out.

Aktobe section

Viséan strata

In the Aktobe section (figs. 2, 5, 6), the upper Viséan component of the succession is represented by intervals 1 to 4, with 1 and 2 representing the upper part of the Baktysay Formation. Interval 1 is 8 m thick and consists of limestone breccia containing brachiopods and corals. Overlying unit 2 is 22 m thick and comprises lime wackestone to packstone interbedded with lime grainstone containing brachiopods and the foraminifers: *Eotuberitina* sp., *Earlandia elegans*, *Endothyra similis*, *Planoendothyra* sp., *Omphalotis* sp., *Archaediscus pauxillus* (Schlykova, 1951), *Pseudoammodiscus* sp. Interval 3 (3 to 5 m thick) contains an algal buildup and represents the lower part of the Akuyuk reef complex (Fig. 5), best developed in the Serpukhovian. Interval 3 contains brachiopods and the foraminifers: *Endothyranopsis crassa* (Brady, 1876), *E.* sp., *Omphalotis timanica* (Durkina, 1959), *Pseudoendothyra* sp., *Forschia mikhailovi* Dain, 1953, *Lituotubella* sp., *Tetrataxis* sp.

Figure 5: Aktobe section showing carbonate buildups (light-coloured mounds) of Akuyuk Reef complex.

Interval 4 of the Aktobe section is 30 m thick and comprises interbedded lime packstone, grainstone and wackestone. The basal horizons contain brachiopods and the foraminifers: *Endothyranopsis* sp., *Planoendothyra* sp., *Omphalotis omphalota*, *Visarionovella tujmasensis* (Vissarionova, 1948), *Asteroarchaediscus baschkiricus* (Krestovnikov & Theodorovich, 1936) and conodonts *Pseudognathodus symmutatus* (Rhodes, Austin & Druce, 1969). In the upper part of the interval, the lime wackestone contains the conodonts *Gnathodus bilineatus* and *Gnathodus girtyi girtyi*.

Serpukhovian strata

Intervals 5, 6 and 7 of the Aktobe section constitute the lower component of the Serpukhovian succession in the section (figs. 5, 6) and are about 10, 5, and 10 metres thick, respectively. Serpukhovian fossils are found in the lime packstone and grainstone of interval 5 and include the following foraminifers: *Endothyranopsis convexus* (Rauser-Chernousova, 1948), *Eoendothyranopsis subtilis* (Solovjeva, 1967), *Eostaffella mosguensis* Vissarionova, 1948, *Mediocris ovalis* (Ganelina, 1951), *Pseudoammodiscus volgensis* Rauser-Chernousova, 1948, *Archaediscus* sp., and *Neoarchaediscus parvus* (Rauser-Chernousova, 1948). Interval 6 contains limestone breccia with corals and unit 7 comprises lime packstone and grainstone. Overlying interval 8 (Fig. 6) of the Aktobe section is more than 26 m thick and contains reef limestone (skeletal lime boundstone) with bryozoans and brachiopods. The lowermost strata yielded *Asteroarchaediscus subbaschkiricus* (Reitlinger, 1949).

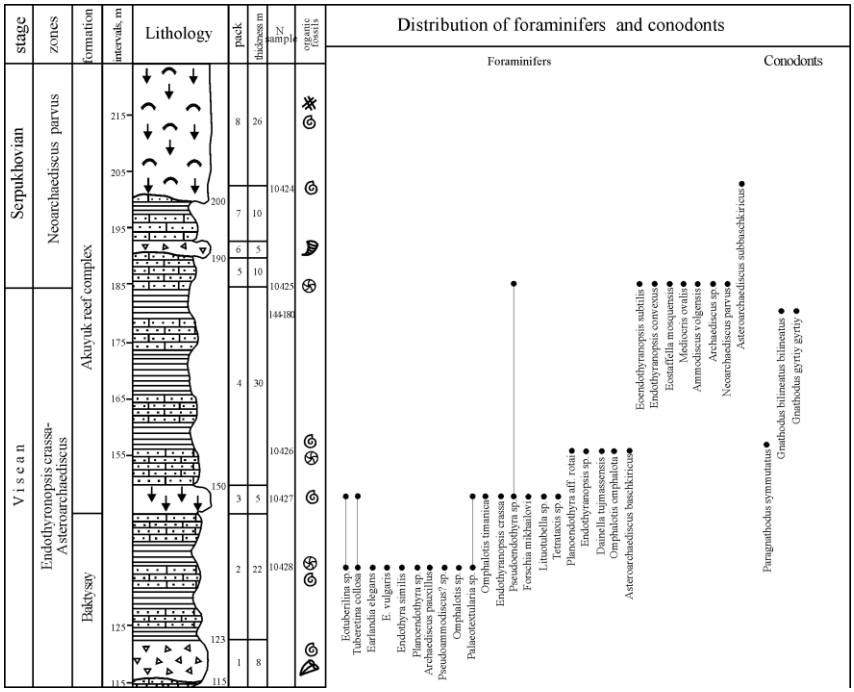

Figure 6: Stratigraphic column showing rock types and distribution of foraminifers and conodonts in the Viséan and Serpukhovian deposits in the Aktobe section. See Figure 2 for legend.

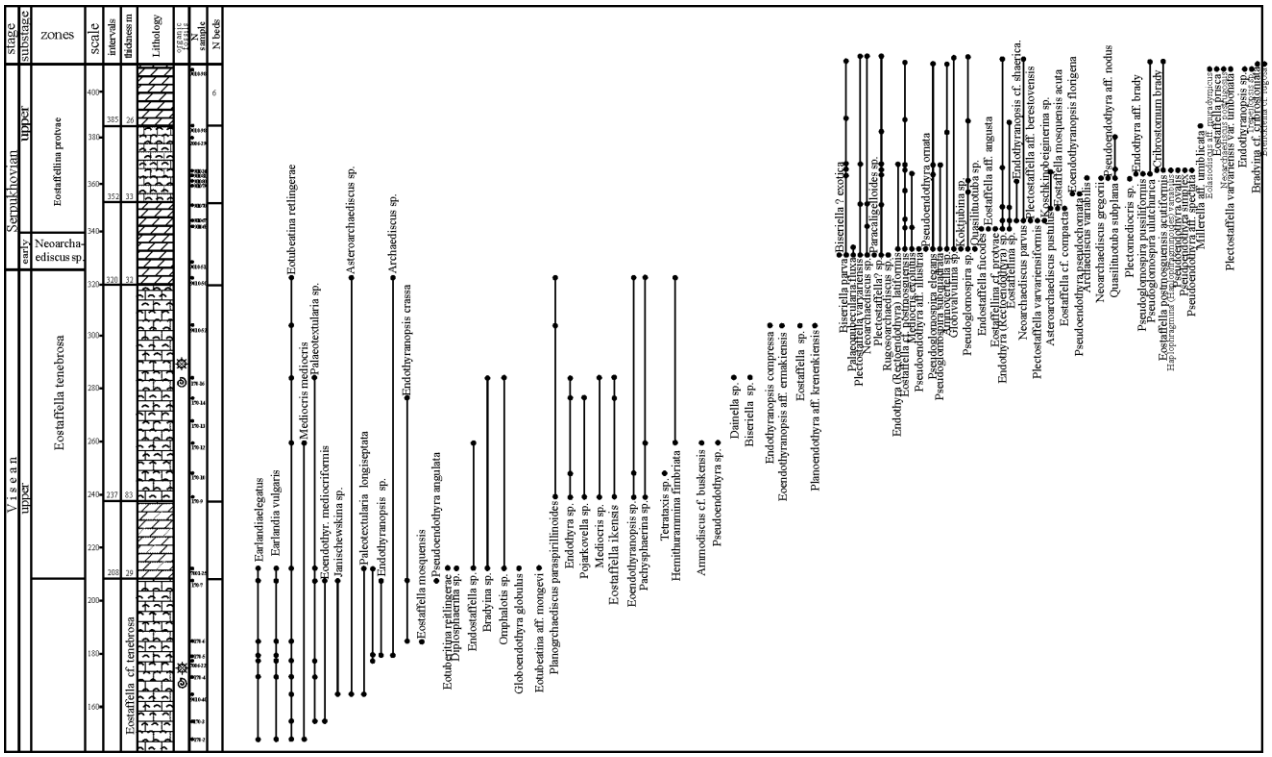

Figure 7: Stratigraphic column showing rock types and distribution of foraminifera in succession spanning Viséan-Serpukhovian boundary in the Zhertansay section. See Figure 2 for legend.

Zhertansay section

The Zhertansay section (figs, 2, 7) consists of shallow-water limestone with subordinate dolostone in the Maydantal Formation. Figure 8 (photomicrographs) illustrates representative rock types and allochems from the strata spanning the Viséan/Serpukhovian boundary. The package of Viséan strata between 150 and 200 m comprises bioclastic lime packstone with brachiopods and the foraminifers *Eotuberitina reitlingerae* (Miklukho-Maclay, 1958), *Diplosphaerina* sp., *Eoendothyranopsis* sp., *Mediocris mediocris* (Vissarionova, 1948), *Mediocris* sp., *Janischewskina* sp., *Pojarkovella* sp., *Planoendothyra* sp., *Pseudoendothyra* sp., *Omphalotis pannusaeformis* (Schlykova, 1951), *Archaediscus* sp., *Planoarchaediscus paraspirillinoides* (Brazhnikova, 1967), *Dainella* sp., *Asteroarchaediscus* sp., and *Palaeotextularia longiseptata* Lipina, 1948, suggesting the *Eostaffella ikensis* Zone.

The interval from 208 to 237 m consists of dolostone. The lower strata in this 29 m thick package of strata are dolomitized limestone but contain the foraminifers *Diplosphaerina maljavkini* (Mikhailov, 1939), *Endothyranopsis crassa* Brady, 1876, *Eoendothyranopsis mediocriformis* Solovjeva, 1967, *E.* aff. *ermakiensis* Lebedeva, 1954, *Globoendothyra globulus* (Eichwald, 1860), *Eostaffella mosquensis* (Vissarionova, 1948), *E. ikensis* Vissarionova, 1948, *E. tenebrosa* Vissarionova,1948, *E. prisca ovoidea* Rauser-Chernousova, 1948, *E. parastruvei* Rauser-Chernousova, 1948, and *Eotextularia* aff. *mongeri* Mamet, 1976 indicating the *Eostaffella tenebrosa* Zone.

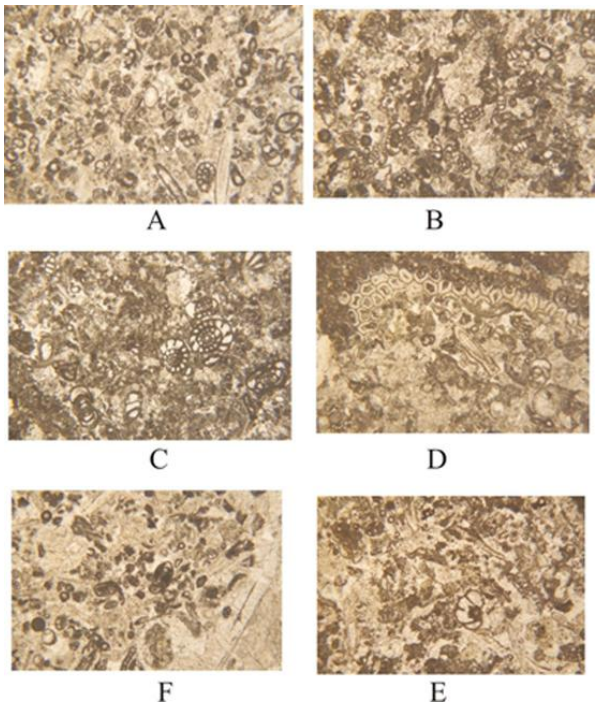

Figure 8: Photomicrographs of representative rock types in the Viséan-Serpukhovian boundary beds of the Zhertansay section. A-E) skeletal lime packstone showing foraminifers and algae.

Higher in the Zhertansay section (interval 237-320 m), the succession is bioclastic lime packstone with brachiopods and foraminifers. In addition to the foraminifers encountered in the underlying interval, the assemblage contains *Eoendothyranopsis* sp., *Planoendothyra* aff. *kedrovica* Durkina, 1959, *Biseriella* sp., *Quasiammodiscus* cf. *buskensis* (Brazhnikova, 1967), and *Tetrataxis* sp. The assemblage indicates the *Eostaffella tenebrosa* Zone.

The interval from 320 to 325 m ranges from 5 to 7 m thick and is dolostone. The lower part of the package of strata contains *Plectostaffella* sp., *P. varvariensiformis* Brazhnikova & Vodovenko, 1983, *Biseriella sp.*, *Biseriella parva* N. Tchernyscheva, 1948, *Neoarchaediscus* sp., and *Rugosoarchaediscus* sp., indicating the basal Serpukhovian *Neoarchaediscus parvus* Zone.

The overlying interval from 325 to 352 m is mainly dolostone but contains beds of dolomitic limestone containing foraminifers of the upper Serpukhovian *Eostaffellina protvae* Zone (Fig. 8).

Ushozen section

The Viséan/Serpukhovian boundary interval in the Ushozen section lies in the Maidantal Formation and comprises shallow-water carbonates with subordinate interbedded paleosols and conglomerate (figs, 2, 9). Unit 1 is 36 m thick and comprises limestone with chert nodules. Overlying unit 2 is 45 m thick and dominated by limestone but overlying unit 3 (26 m thick) contains chert nodules. Unit 4 (50 m thick) contains an alternation of oolitic limestone and subordinate dolostone. Units/intervals 1 to 4 contain the following foraminifers: *Planoarchaediscus spirillinoides* Rauser-Chernousova, 1948, *Uralodiscus rotundus* (N. Tchernysheva, 1948), *Endothyranopsis compressa* Rauser-Chernousova & Reitlinger, 1940 and *Archaediscus krestovnikovi* Rauser-Chernousova, 1948. The associated brachiopods suggest the deposits lie within the *Globosoproductus sarsimbai* Zone.

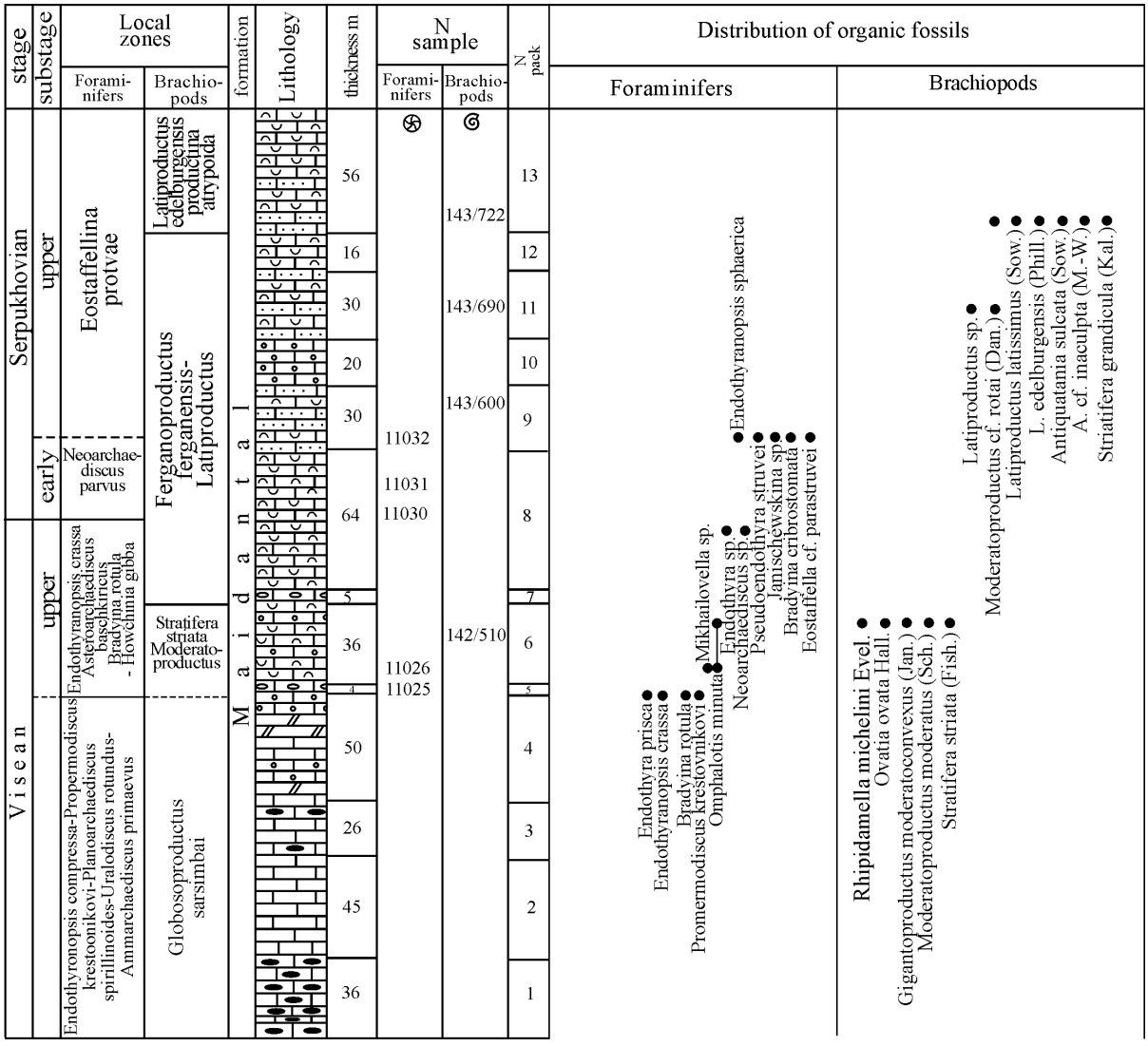

Figure 9: Stratigraphic column showing rock types and distribution of foraminifers in the Ushozen section.

Endothyranopsis crassa and *Bradyina rotula* appear in interval 5, which is 4 m thick and comprises calcareous conglomerate. Interval 5 also contains *Endothyra prisca*, and *Archaediscus krestovnikovi*. Higer in the Viséan component of the section, unit 6 (36 m thick) comprises skeletal lime rudstone (coquina) containing *Omphalotis minuta* and *Mikhailovella* sp. Calcareous conglomerate of unit 7 (5 m thick) overlies the coquina and is in turn overlain by skeletal lime rudstone (coquina) of interval 8, which is 64 m thick and spans the Viséan/Serpukhovian boundary. *Neoarchaediscus* sp. appears in the middle of interval 8 suggesting the lower Serpukhovian substage. Lime grainstone interbedded with shell-rich lime packstone constitute unit 9 (30 m thick), which contains the appearance of *Endothyranopsis sphaerica* (Rauser-Chernousova & Reitlinger, 1936), *Pseudoendothyra struvei* Möeller, 1880, *Eostaffella* cf. *parastruvei* Rauser-Chernousova, 1948, *Bradyina cribrostomata* Rauser-Chernousova & Reitlinger, 1940, *Janischewskina* sp. and other foraminifers of the *Eostaffellina protvae* Zone (upper Serpukhovian). Overlying interval 10 (20 m thick) comprises oolitic lime grainstone that passes upward into alternating fine-grained limestone and shell-rich (rudaceous) lime packstone. The succession extending form unit 7 to unit 12 contains brachiopods assignable to the *Ferganoproductus ferganensis – Latiproductus* Zone.

Summary of the carbonate facies of the Big Karatau Mountains

There are two types of carbonate sections in the northwestern Big Karatau Mountains. 1) The first type is dominated by deep-water facies comprising interbedded lime wackestone and turbiditic lime grainstone; minor lime packstone associated with bryozoan-algal and algal carbonate buildups (mounds) are also present. 2) In contrast, the second type of section is dominated by shallow-water deposits comprising lime packstone, dolostone, and oolitic lime grainstone.

The upper Viséan portion of the Zhanakorgan section (figs. 2, 3, 4) is dominated by lime wackestone interbedded with coarse-grained, lime grainstone turbidites. The upper Serpukhovian portion of the section is dominated by lime wackestone. All of the deposits in the section are assigned to the Baktysay Formation, which is interpreted to have been deposited in slope to basinal settings. In this region, the inter-turbiditic, micritic limestone contains sponge spicules and radiolarians, whereas the intercalated turbiditic lime grainstone beds contain foraminifers.

In the Aktobe section (figs. 2, 5, 6), the lower portion of the upper Viséan succession comprises alternating lime wackestone, packstone and grainstone beds of the Baktysay Formation, which are associated with beds of coarse-grained breccia that are interpreted to be of debris-flow origin and contain corals and brachiopods. Conodonts have been extracted from the lime wackestone intervals. The middle portion of the Viséan interval contains an algal buildup (lime boundstone) with brachiopods and represents part of the Akuyuk reef complex. The upper Serpukhovian component of the section is mainly lime packstone and grainstone alternating with lime wackestone but contains a breccia bed. The Aktobe section is capped by the Akuyuk reef complex comprising algal-bryozoan lime boundstone with foraminifers, brachiopods, and corals.

Shallow-water facies of the Maydantal Formation are observed in the Zhertansay (figs. 2, 7) and Ushozen (figs. 2, 9) sections. The upper Viséan interval in the Zhertansay section begins with karst breccia overlain by skeletal lime wackestone and packstone interbedded with oolitic lime grainstone containing foraminifers and brachiopods. In the Ushozen section, the upper Viséan deposits comprise lime grainstone and packstone containing foraminifers and brachiopods but conspicuous beds of limestone conglomerate (units 5, 7) lie within the succession. Above conglomeratic unit 5, the upper Viséan interval begins with a succession of peloidal limestone overlain by skeletal lime boundstone with algae (*Ivanovia*) and further up by skeletal wackestone and packstone with foraminifers and brachiopods.

Foraminifera-based correlations

Marfenkova (1991) was the first to recognize foraminiferal zones in the Big Karatau Mountains. Baybatsha *et al*. (2013) continued with the research on the foraminifers and some of their work is summarized herein. Both the shallow- and deep-water facies contain assemblages of upper Viséan and lower Serpukhovian foraminifers. In this study, the base of the Serpukhovian is drawn at the level of the first appearance of the foraminifer *Janischewskina delicata*, and in places where *J. delicata* is not found, the boundary is placed at the first appearance of *Neoarchaediscus parvus*, *Biseriella parva*, and *Endostaffella parva.* Within the Big Karatau Mountains, the correlation of deep- and shallow-water carbonate facies is based on species of *Neoarchaediscus* and *Janischewskina*.

Conclusions

The correlation of the Viséan and Serpukhovian beds of the northwest Big Karatau Mountains is based on mainly on foraminifers. Some conodont work has been done, but it is at a preliminary level and *Lochriea ziegleri*, currently used to define this boundary in other regions such as the southern Urals of Russian (Nikolaeva *et al*., 2009; Pazukhin *et al*., 2010), has not been located. Substantial additional research is required to refine the foraminiferal

zonation and determine the first occurrence of *L. ziegleri*.

Acknowledgements

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CORRECTION FOR PONOMARENKO & REMIZOVA (2013): ESTABLISHING THE MOSCOVIAN–KASIMOVIAN BOUNDARY IN THE NORTHERN URALS (THE ILYCH RIVER). - NEWSLETTER ON CARBONIFEROUS STRATIRGAPHY, 30: 53-55

After the the last newsletter had been published, the authors signalized two mistakes, which have been made during the editorial process of their manuscript (Ponomarenko & Remizova, 2013).

On page 54 the correct authorship for the species *Kanmeraia solovievae* is Remizova (1995) and not Ivanova as was erroneously deducted from the intenet resources making reference to *Kanmeraia solovievae* Ivanova, 1997 in *Biostratigraphy and taxonomy of Carboniferous-Permian fusulinellids of the Urals. Biostratigraphy and microorganisms of the Phanerozoic of Eurasia. [Transactions of the 12th] all Russian micropaleontological conference devoted to the centenary of D.M. Rauser-Chernousova., GEOS, Moscow., 1997: 1-303. Chapter pagination: 22-28. [Zoological Record Volume 136].*

Ivanova (2008) renamed the species *Kanmeraia solovievae* Ivanova, 1997 into *Kanmeraia remizovae* Ivanova, 2008.

During pagination of the newsletter, Fig. 3 was omitted. This figure is included herein.

The editor appolagizes for any convenience and confusion this might have caused.

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PONOMARENKO, E.S. & S.T. REMIZOVA. (2013): Establishing the Moscovian–Kasimovian boundary in the northern Urals (the Ilych River). - *Newsletter on Carboniferous Stratigraphy*, **30**: 53-55

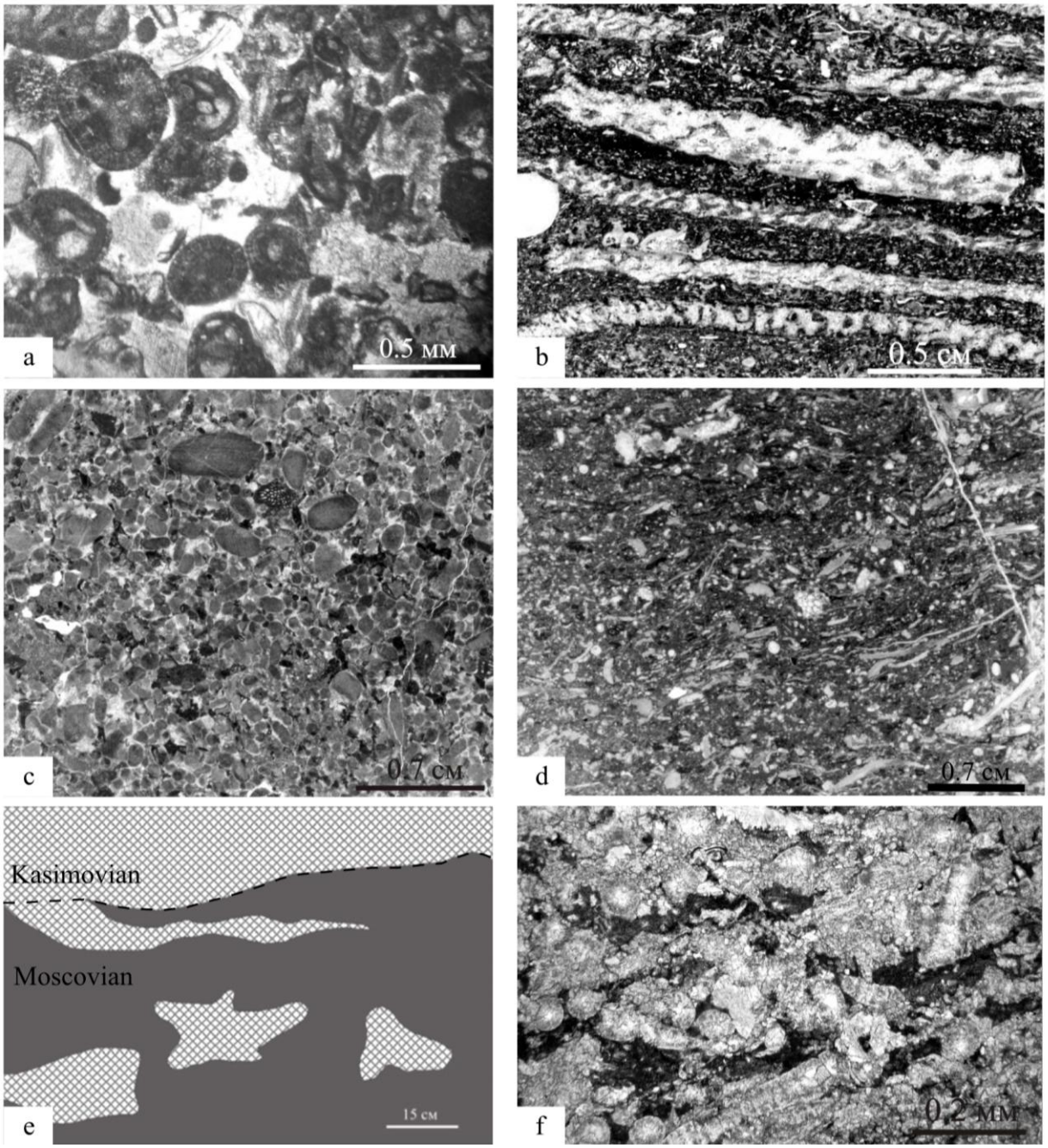


Figure 3: Common lithologies: A) bioclastic-oolithic grainstone at the base of the Kasimovian, outcrop No. 70, B) Palaeoaplysinid bafflestone, typical for the Kasimovian deposits. C) Crinoid grainstone with rare fusulinoids from lowermost part of the Kasimovian in outcrop No. 84, D) Bioclastic packstone – main lithology in the Moscovian and Kasimovian deposits, E) Field sketch of the erosional boundary in the outcrop No. 84. F) Algal bafflestone – typical lithology for the Moscovian deposits; more rare in the Kasimovian.

MEETINGS

SCCS Activities in 2012-2013

March 2013, Erfoud, Morocco

The Devonian and Lower Carboniferous of northern Gondwana

International Field Symposium of SDS, SCCS and Task Group "Devonian–Carboniferous Boundary",

May 2013, Albuquerque, USA

The Carboniferous-Permian Transition

Future Meetings

2014

CPC 2014: Field Meeting on Carboniferous and Permian Nonmarine – Marine Correlation

Dates: 21 – 27 July

Venue: Freiberg, Germany

Website:

http://tu-freiberg.de/geo/palaeo/schneidj/cpc-2014

4th International Palaeontological Congress

Dates: September 28 – Oktober 4

Venue: Mendoza, Argentinia

Contacts:
ipc4chairs[at]mendoza-conicet.gov.ar
ipc4secretary[at]mendoza-conicet.gov.ar

Website: http://www.ipc4mendoza2014.org.ar

Kazan Golovkinsky Stratigraphic Meeting, 2014

Dates: 20-23 October

Venue: Kazan, Russia

Website: http://kpfu.ru/stratikazan2014

2015

18th International Congress on the Carboniferous and Permian

Dates: August 7-15

Venue: Kazan, Russia

Organizing committee: A.S.Alekseev, I.V.Budnikov, A.S.Byakov, B.I.Chuvashov, I.R.Gafurov, V.G.Golubev, N.V.Goreva, O.L.Kossovaya, G.V.Kotlyar, E.I.Kulagina, D.K.Nourgaliev, S.V.Nikolaeva, and V.V.Silantiev

For further information, please contact: iccp2015[at]ksu.ru.

website: http://www.iccp2015.ksu.ru

FIRST CIRCULAR

XVIII INTERNATIONAL CONGRESS ON THE CARBONIFEROUS AND PERMIAN (ICCP 2015)

Invitation

It is our privilege and pleasure to invite you to the XVIII International Congress on the Carboniferous and Permian, to be held at the Kazan Federal University, City of Kazan, Russia, August 11 – August 15, 2015.

The Carboniferous and Permian successions of Russia have a long history of study and are renowned for excellent outcrops that occur over a vast territory, a considerable variety of depositional types, and abundant fossils. This makes Russia one of the most famous and popular locations for basinal studies, global and regional tectonic reconstructions, paleogeographical and biostratigraphic research, and upper Paleozoic fossil collecting. Carboniferous and Permian research in Russia has recently seen a marked increase in activity. National and international projects have focused on documentation of candidates for global stratotypes for stage and substage boundaries in historical and newly discovered sections, and paleotectonic reconstructions of the Uralian Ocean, leading to new interpretations of the evolution of the Paleo-Tethys. Considerable progress was made in the study of Carboniferous and Permian successions in Siberia and the Russian Far East. Exciting fossil excavations revealed new faunas in the Cis-Uralian Region, which in combination with modern geochemistry technologies has led to great advances in our understanding of the paleoclimate at the end of the Paleozoic, and new insights into the causes and consequences of Carboniferous-Permian events, especially the P-T extinction. The ICCP-XVIII Congress in Kazan will provide an important forum for discussion of the most relevant cutting-edge topics of Carboniferous-Permian geology and paleontology, and a unique opportunity to see and collect from exceptional geological localities in the European and Asian regions of Russia.

General sponsors

Russian Academy of Sciences

Interdepartmental Stratigraphic Committee of Russia

Carboniferous and Permian Commissions of Russia

The International Subcommission on Carboniferous Stratigraphy

The International Subcommission on Permian Stratigraphy

Congress Organizers

Kazan (Volga region) Federal University

Lomonosov Moscow State University

A.P. Karpinsky Russian Geological Research Institute (VSEGEI), St. Petersburg

The Paleontological Institute, Russian Academy of Sciences, Moscow

The Geological Institute, Russian Academy of Sciences, Moscow

Perm State National Research University

The Zavaritsky Institute of Geology and Geochemistry, Russian Academy of Sciences, Ural Branch, Ekaterinburg

Institute of geology of the Ufimian scientific centre, Russian Academy of Sciences, Ufa

North-East Interdisciplinary science research institute, Russian Academy of Sciences, Far East Branch, Magadan

Scientific Committee

Alexander S. Alekseev, Igor V. Budnikov, Alexander S. Biakov, Zhong Q. Chen, Boris I. Chuvashov, Ilshat R. Gafurov, Valeriy K. Golubev, Natalia V. Goreva, Olga L. Kossovaya, Galina V. Kotlyar, Elena I. Kulagina, Danis K. Nourgaliev, Svetlana V. Nikolaeva, Victor V. Ogar, Galina Y. Ponomareva, Barry C. Richards, Shuzhong Shen, Vladimir V. Silantiev

Venue

The City of Kazan is among the most ancient cities in Russia. With a population of 1.2 million people, it is a cultural and industrial center included in the UNESCO World Heritage list, and its mosaic of Muslim and Christian architecture contributes to its unique atmosphere and scenery. Kazan is easily accessible from Europe via Frankfurt, Moscow or St. Petersburg, and its position in the center of European Russia makes it an ideal base from which to explore a wide variety of sections and outcrops located in several adjoining districts of Russia.

Schedule for 2015

August 10: Arrival to Kazan, Registration and welcome reception

August 11 – August 15: Talk and poster sessions, workshops

August 13: Mid-Congress field excursions and Congress banquet

August 16: Departure from Kazan

Travel

By air to Kazan via Moscow or St. Petersburg.

By train to Kazan via Moscow (12 hours) or St. Petersburg (14 hours).

Obtaining a visa to visit Russia: Please check to see if your visit to Russia will require a visa. http://www.visitrussia.org.uk/visaform/not-need/ or http://ru.vfsglobal.co.uk/ The process involves contacting the nearest Russian embassy or consulate in the country where your passport is issued. We will send an official invitation letter issued by Kazan University to delegates who need to apply for a visa. Please send us a request for a visa invitation.

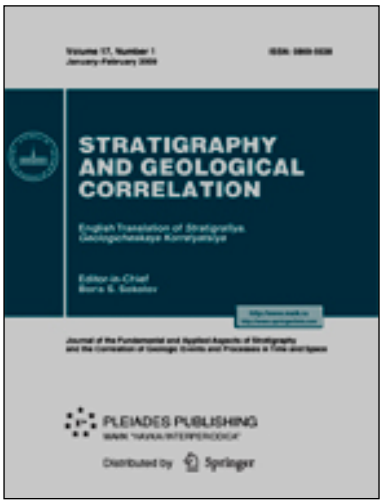
Scientific Programs

Meeting Format: The meeting will consist of concurrent sessions of talks, each of 20 minutes (including questions and discussion). Talks will be grouped based on broad geological topics. There will be one poster session, which will include afternoon refreshments. Speakers will normally be limited to one presentation (talk) at the meeting. Individuals may participate as a non-presenting coauthor on additional talks. Individuals may participate in as many posters presentations as they wish. Details will follow in the Second Circular.

Session titles

1. Carboniferous stage boundaries, stratotype sections, and GSSPs
2. Permian stage boundaries, stratotype sections, and GSSPs
3. Carboniferous and Permian high-resolution stratigraphy (multi-proxy correlations)
4. Late Paleozoic glaciations and interglacials: impact on ecosystems and sedimentation
5. Carboniferous and Permian plate tectonics and orogenies
6. Late Paleozoic marine macrofossils: systematics, biostratigraphy, and paleobiogeography
7. Late Paleozoic continental biota: systematics, ecosystems, and paleobiogeography
8. Micropaleontology: systematics, phylogeny and biostratigraphy
9. The terrestrial late Paleozoic world: paleosols, lithofacies, and environments
10. Sequence stratigraphy and cycles
11. Late Paleozoic reefs, biostromes, and carbonate mounds
12. Cold-water to tropical carbonate lithofacies and environments
13. The late Paleozoic oceans: paleoceanography
14. Latest Devonian and mid-Carboniferous extinctions and recovery
15. End-Permian mass extinction and Early Triassic recovery
16. Carboniferous and Permian coal and mineral deposits
17. Eurasian conventional and unconventional hydrocarbon systems

Call for Abstracts: Abstracts for the meeting are due on April 1, 2015. A request for abstracts will be announced in the Second Circular, which will also have instructions for electronic submission. The Abstract volume for the meeting will be edited by Alexander A. Alekseev, Galina V. Kotlyar, Svetlana V. Nikolaeva and distributed to registered delegates at the meeting.



Proceedings Volume: Congress proceedings are planned for publication in two bimonthly peer-reviewed scientific journals of MAIK "Nauka/Interperiodica" publishing house.

Stratigraphy and Geological Correlation (Stratigrafiya, Geologicheskaya Korrelyatsiya) covering fundamental and applied aspects of stratigraphy and the correlation of geologic events and processes in time and space.

Paleontological Journal (Paleontologicheskii Zhurnal) is oriented toward the anatomy, morphology, and taxonomy of fossil organisms, as well as their distribution, ecology, and origin. It also publishes studies on the evolution of organisms, ecosystems, and the biosphere and provides information on global biostratigraphy.

Manuscripts for the proceedings volumes

are encouraged, and should be prepared following the Guide for Authors (http://www.maik.rssi.ru/). Contributed papers relating to the topics of IC participants. Please note that the deadline for contributions to the proceedings 30, 2015.

Workshops: Several free workshops will be scheduled and are mainly designed Carboniferous and Permian stratigraphy.

Any colleagues or working groups wishing to hold a special symposium or worl organizers with their ideas no later than December 31, 2014.

Language: The official language for the scientific program and all business of the

Proposed Field excursions

A. Pre-congress excursions:

A1. Lower Carboniferous of the St. Petersburg region (north-western Russia).

A2. Moscow Basin. Stratotypes of the Serpukhovian, Moscovian, Kasimovian and Gzhelian stages.

A3. Southern Urals. Deep water successions of the Carboniferous and Permian. Lower Permian GSSPS.

A4. Middle Permian – Lower Triassic continental sequences in Vologda and Arkhangelsk regions (north of Europe tetrapods, non-marine fishes and invertebrates.

B. Mid-congress excursion:

B1. Permian deposits and historical-cultural sites along the Volga River (boat tour).

B 2. Middle Permian paleosols in succession of the Urzhumian Stage around Kazan.

C. Post-congress excursions:

C1. Volga and Kama Region. Middle and Upper Permian.

C2. Middle Urals. Carboniferous and Permian marine and continental successions.

C3. Carboniferous reference sections: potential candidates for the base of the Serpukhovian GSSP, organic buildup

Dates and payment for field excursions will be detailed in the Second Circular.

Guest Program: No formal guest program is planned at this time. However, the congress organizers can help coordinate local excursions to suit most interests. Feel free to request information, provide suggestions or share potential interests. See the Official Kazan City Guide at http://gokazan.com/

Accommodation: A large variety of hotels is available in the city of Kazan (see the ICCP website). Kazan Federal University will provide low cost dormitory accommodation for all students – participants of the Congress – in the 2013 Summer Universiade Games Village.

Travel insurance: Participants should have valid health insurance for the entire journey. All foreign participants are required to bring with them health insurance contracts, covering the period of the trip, from an insurance company that provides an international insurance policy.

Climate: Kazan has a continental climate with warm, often hot, dry summers. August is hot, average 21°C to 25°C, infrequently exceeding 33°C or dropping below 16°C. There is a possibility of light rain. Overall it is pleasant.

Type of clothing and weather conditions: For the field excursions, you are advised to bring sturdy field boots (rubber boots could be useful), a raincoat, and a hammer. All hotel rooms are normally air-conditioned.

REGISTRATION

Registration form will be available on the Congress website: www.ICCP2015.kpfu.ru after March 1, 2014.

Registration fees:

	Before April 1, 2015 (Early Bird)	**After April 1, 2015**
Regular participant	400 Euro, this price is inclusive of the Congress fee, the volume of Abstracts, and refreshments during session breaks	450 Euro; this price is inclusive of the Congress fee, the volume of Abstracts, and refreshments during session breaks
Student	200 Euro as above: students must show a valid student ID card	250 Euro as above: students must show a valid student ID card
Accompanying person	80 Euro, as above: with the exception of the volume of Abstracts	100 Euro, as above: with the exception of the volume of Abstracts

Geohost program

The organizers are trying to raise funds to support regular participants and students from countries with struggling economies. The funds will be used to waive the registration fee and to pay the accommodation during the Congress. If your participation in the Congress depends on such financial support, please fill in the application form on the Congress website: www.ICCP2015.kpfu.ru or kpfu.ru/iccp2015

Important Dates

March 1, 2014: First Circular available for distribution and online.

February 1, 2015: Second Circular available for distribution and online.

March 1, 2015: Deadline for Application form to the Geohost program.

April 1, 2015: Deadline for Early Bird payment and abstract submission.

May 1, 2015: Third Circular available for distribution and online.

October 30, 2015: Deadline for manuscript submission to the Proceedings volumes.

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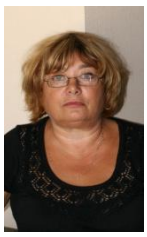

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