1. TITLE OF CONSTITUENT BODY and NAME OF REPORTER

SUBCOMMISSION ON CARBONIFEROUS STRATIGRAPHY

ANNUAL REPORT **2013**

SUBMITTED BY
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2. 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 at the top 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*., 2002a), 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.

3a. CHIEF ACCOMPLISHMENTS AND PRODUCTS IN November 1st 2012 - October 31st 2013 fiscal year

Task Group Progress Reports

The references for the task-group reports are provided after Appendix A.

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group [base Carboniferous also the base of the Lower Mississippian Series and Tournaisian Stage] was established in early 2008 and is chaired by Markus Aretz (France; aretz@get.obs-mip.fr).

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 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.

Barry Richards (Calgary, Canada)

Richards and colleagues (Mark Schmitz and 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 outcrop sections in the southern Canadian Rockies for stable carbon isotope ($\delta^{13}C$) chemostratigraphic and magnetic susceptibility studies.

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) and 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 MSc 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 to establish the Tournaisian-Viséan Boundary [which is also the base of the Middle Mississippian Series] is chaired by George Sevastopulo (Ireland; gsvstpul@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@canada.ca).

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 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).

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 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 progress) was largely 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 & 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*., 2002, 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 preparation), 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. 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 preparation) 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 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@geol.msu.ru).

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. 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).

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. 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, 2011) 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 (Bender, 1980), and South America. 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 were systematically sampled for stable carbon isotope ($\delta^{13}C$) chemostratigraphy.

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. 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 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@fukuoka-u.ac.jp).

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.

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, discussed below, is to use the first occurrence of *Idiognathodus heckeli* Rosscoe & Barrick, 2013. No formal proposal for a marker species to define the base of the Kasimovian Stage has been presented.

Progress in North America

Rosscoe & Barrick (2013) documented in detail the morphological transition from *Idiognathodus swadei* Rosscoe & Barrick, 2009a 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) 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 lacks 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.

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 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. Gusel Sungatullina (Kazan University, Russia) is restudying the conodonts across the boundary within the Usolka section. Alexander Alekseev expects the results of Gusel's study will 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 continued investigation of the Naqing 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 *I. simulator* fauna at Naqing is moderately abundant and diverse; consequently, it can at least serve as an important reference section for the boundary. The gap and rarity of other fossils, however, are the drawbacks. Moreover, Qi & 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 occur. His research will likely provide a more restricted concept of *I. simulator* than the 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.

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 in the USA. 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@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.

Progress by the project group has been hampered by a shortage of members, insufficient funding, and a lack of integration with the activities of the other SCCS task groups. The group is particularly interested in collaborating with task groups working on sections and boundaries where magnetostratigraphy could be employed, to facilitate international correlations. Sections that have low thermal maturity and are dominated by siliciclastics are the most suitable for magnetostratigraphic analyses (See review in Newsletter on Carboniferous Stratigraphy, v. 22: 35-41) but carbonates can be used.

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

The meeting in Morocco 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 results of recent work and their abstracts were published the Abstract volume for the conference (El Hassani *et al*., eds., 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 Task group to redefine the D-C boundary held an important business meeting at the conference and the key points are summarized above under the progress report for that task group. One of the main goals of D-C boundary task group at the meeting was to establish work plans for the next two to four years on the basis of the presentations and discussions.

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*., eds., 2013a). Members of several task groups along with corresponding members presented the results of 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). The SCCS held a business meeting at the conference and the key points will be published in the executive's column of volume 31 of the Newsletter on Carboniferous Stratigraphy.

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.

3b. 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 interest. Volume 30 also contains a revised directory for the corresponding membership. The Newsletter provides a significant outlet for 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 have 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 this Annual Report.

Perhaps the most important outputs during the year are:

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.

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.

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.

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.

Website

During the Nov. 1st, 2012 to Oct. 31st 2013 fiscal year, the SCCS revised its 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 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 a 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.

3c. 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. The problem is being overcome somewhat by correlating other fossil groups to bracket the boundary levels in major regions where the boundary-event taxa have not been found. 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.

Essentially all lineages being chosen for GSSP definition are conodont based and have the most utility in carbonate-dominant lower-slope and basin deposits containing few other taxa than ammonoids that are suitable for global correlations. The best of the known deeper water successions in terms of abundance and diversity of conodonts and continuity of outcrop are in southern China and the southern Urals. The direction the current work of the SCCS is advancing indicates all of the remaining GSSPs will be placed in south China and Russia.

4a. WORK PLANS, CRITICAL MILESTONES, ANTICIPATED RESULTS AND COMMUNICATIONS TO BE ACHIEVED NEXT YEAR (2014):

The following activities are planned for the Nov. 1, 2013 to Oct 31, 2014 fiscal year by the task groups, as communicated by task-group chairs and distilled from the reports in # 3a above.

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 with the possible exception of the base of the Tournaisian.

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

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group 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* 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.

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), 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 and 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.

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.

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 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*., 2009a, b; 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 is preparing a preliminary paper on the lithostratigraphy and

sedimentology of the lower part of the section including the boundary interval (Richards *et al*. in preparation). The team will be showing the section on a fieldtrip associated with the XVIII International Congress on the Carboniferous and Permian in Kazan, Russia in August 2015. The Kardailovka section contains several volcanic ash layers slightly below 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.

Bashkirian-Moscovian boundary The task group plans to continue evaluating conodont lineages suitable for definition of the Bashkirian-Moscovian boundary and anticipates 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 and southern Urals.

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. 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).

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.

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, 2009a 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. 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 for 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 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*.

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. Gusel Sungatullina (Kazan University) will continue to investigate the conodonts from Usolka.

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.

Work plans B.

Meeting-field workshop schedule with themes and anticipated results.

During the November 1, 2013 - October 31, 2014 fiscal year, no major workshops are planned but 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. 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.
There are several conferences during the current fiscal year that will be of interest to members (see list of conferences in 2014 issue of Newsletter on Carboniferous Stratigraphy) but task-group workshops have not been planned for these.

XIVIII International Congress on the Carboniferous and Permian

Dates: August 7-15, 2015
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, & V.V. Silantiev
Contact: iccp2015@ksu.ru
Website: http://www.iccp2015.ksu.ru
The first circular was published in volume 29 of the newsletter and the second circular will be ready in 2014.

4b. Specific GSSP Focus for 2014

Viséan-Serpukhovian boundary

5. 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 -	$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 Nov. 1, 2013 - Oct. 31, 2014 fiscal year)	**$706.62**

6. 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 INCOME	$1,906.62
BALANCE	
Estimated (deficit) / credit from above	$906.62
BUDGET REQUEST FROM ICS for 2014	$1,000.00

APPENDIX A

7. 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 now provides the Carboniferous with its official global series and stage names (Heckel & Clayton, 2006a, 2006b), and all effort is now focused on selecting events and GSSPs for stage boundaries.

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 serious problems with the integrity of the GSSP caused Thomas Becker (former Chairman of Subcommission on Devonian Stratigraphy) and Philip Heckel (former Chairman of SCCS) to establish the joint Devonian-Carboniferous Boundary GSSP reappraisal task group in 2008. In June 2010, the SCCS Chairman Barry Richards appointed Markus Aretz to chair the task group.

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). The conodont studies have been disappointing because 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. More data, however, on the precise timing of phases of the Hangenberg and the correlation of the biostratigraphic, geochemical, sedimentologic and sequence stratigraphic patterns within it are needed to evaluate the event's potential 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*. Although an event for boundary definition boundary has not been chosen, the search for better GSSP sections is progressing. New D-C boundary sections are being evaluated and previously studied sections such as the Hasselbachtal in Germany and those in southern China (Ji *et al*., 1989) 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*., 2009b; 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 a synthesis published about the ammonoids, conodonts, and ostracodes (Nikolaeva *et al*., 2009a,b). The synthesis indicates conodonts that are transitional between *L. nodosa* and *L. ziegleri* occur in the section immediately below the FAD of *L. ziegleri.* Prior to 2010, extensive parts of the section were poorly exposed but during August 2010 and 2011 the covered components of the section were excavated and permanent aluminum marker pins placed at one metre intervals in preparation for a bed-by-bed sedimentological analysis and the systematic sampling for conodonts, stable-isotope geochemistry and magnetic susceptibility studies, which were largely completed in 2011 and 2012.

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 Naqing section, conodonts within the *L. nodosa - L. ziegleri* lineage are well preserved and abundant. Elements transitional between *L. nodosa* and *L. ziegleri* are plentiful, occurring through several metres of section. A detailed stratigraphic section extending from the upper Viséan into the Bashkirian has been measured at Nashui and aluminum marker pins placed at one-metre intervals through the section. 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 in time for the November 2010 SCCS workshop and field meeting in Nanjing. His work (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) but the biostratigraphic and sedimentologic work at the two localities is less advanced than at the Nashui and Verkhnyaya Kardailovka sections.

Work has been initiated on ammonoid-rich successions in the western U.S.A. (Korn & Titus, 2011), southern Urals of 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).

Although the *Lochriea* lineage along with associated faunas and strata are being studied in several areas, the task group has concluded the Naqing (Nashui) section in China and the Verkhnyaya Kardailovka section in Russia have the best potential as GSSP candidates.

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 northwest Spain, Javier Sanz-López, Silvia Blanco-Ferrera and Elisa Villa are conducting integrated foraminifera and conodont biostratigraphic analyses at the San Antolin-La Huelga section along the Bay of Biscay in the Cuera area (Bahamonde *et al*., 2008). The Bashkirian-Moscovian boundary is provisionally placed about 180 m above the base of the section. The boundary is marked by the lowest occurrence of *Idiognathoides postsulcatus*, and this level is slightly higher than the lowest occurrences of *Declinognathodus marginodosus* and *Profusulinella* ex gr. *prisca*. The San Antolin-La Huelga section contains four conodont taxa identified as potential Bashkirian-Moscovian Boundary markers: *Id. postsulcatus, Diplognathodus ellesmerensis, Neognathodus nataliae* and *Declinognathodus donetzianus*.

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. Several task-group members have proposed that the first appearance of *D. ellesmerensis* be considered as the marker event for this boundary because of its distribution is broader than that of *D. donetzianus.*

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-metre 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.

During 2010, Qi Yuping and Lance Lambert were examining conodonts from the Naqing section that span the Bashkirian-Moscovian Boundary interval and discovered that rapid morphologic evolution in P_1 elements of *Streptognathodus expansus* and *S. suberectus* permit the identification of a new and possibly better biostratigraphic level at which the base of the Moscovian might be placed and presented initial findings (Qi *et al*., 2010) at a November 2010 SCCS workshop and field meeting in Nanjing, China. They advocated placement of the base of the Moscovian at the joint first appearances of advanced morphotypes of *Streptognathodus expansus* and *Streptognathodus suberectus* in the Nashui section. That level coincides with the local appearance of *Neognathodus kanumai* and it occurs approximately 4 m below the local appearance of *Diplognathodus ellesmerensis*, an event previously identified as a potential boundary marker.

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.

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. 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). In 2009 SCCS geologists examined the section and discovered it required substantial excavation work and additional study before a proposal could be put to ballot. Gusel Sungatullina (Kazan University) is investigating 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.

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).

During the May 31st to June 3rd 2010 ICS meeting in Prague, the project-group leader discussed with Barry Richards and Svetlana Nikolaeva the possibility of designing a magnetostratigraphic project that would evaluate Late Mississippian and Pennsylvanian sections in the Moscow Basin, Liard Basin in northwestern Canada and sections in the mid-continent region of the USA. So far, these initial discussions have not developed into tangible outcomes and the main problems stem from a lack of funding and suitable investigators.

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). 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.

8. 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 (Webpage:

http://www.israbat.ac.ma/seminaires.htm) that lead to substantial progress on selecting the boundary event and provided direction for future research. Following selection of the event, suitable candidate sections for the GSSP must be located.

Since the project was initiated in 2008, substantial progress has been made on evaluating potential conodont event markers. Corradini & Kaiser (2009) re-evaluated the *Siphonodella praesulcata* - *Siphonodella sulcata* lineage used to define that boundary and Corradini *et al.* (2010; 2011) along with other conodont experts have studied the protognathodids, the other conodont group that had potential for boundary definition. It appears that neither the siphonodellids nor the protognathodids are suitable for D-C boundary definition. There is, however, some hope the siphonodellid lineage can still be used because considerable disagreement exists among conodont specialists about its utility and the conclusions of Kaiser & 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.

At the International Commission of Stratigraphy meeting held in Prague from May 31st to June 3rd, 2010 to discuss the GSSP concept, Vladimir Davydov (Boise State University, Idaho USA) proposed that volcanic-ash layers could be used to define boundaries such as the D-C boundary. Ash layers represent instants in deep time and can be precisely dated using U-Pb isotope dilution thermal ionization mass spectrometry (ID-TIMS) methodology.

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*., 2009a, b; Pazukhin *et al*., 2010). 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.

The **Moscovian-Kasimovian Boundary and Kasimovian-Gzhelian Boundary Task Groups** are moving ahead as the previously muddled conodont taxonomic problems have been largely resolved.

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 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 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 (discussed below) 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. Gusel Sungatullina (Kazan University, Russia) is restudying the conodonts across the boundary within the Usolka section. Alexander Alekseev expects the results of Gusel's study will permit the Usolka section to be used 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.

9. 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).

9a. *NAMES AND ADDRESSES OF CURRENT OFFICERS AND VOTING MEMBERS*

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9b. *WORKING GROUPS/TASK GROUPS AND OFFICERS*

The SCCS has six current task groups and one exploratory Project Group:

Task Groups and officers

The joint Devonian-Carboniferous Boundary GSSP Reappraisal Task Group [base of Carboniferous is also the base of the Lower Mississippian Series and Tournaisian Stage] was established in early 2008 and is chaired by Markus Aretz (France; aretz@get.obs-mip.fr). It comprises members appointed by Thomas Becker former Chairman of the Devonian Subcommission (SDS) and members selected by Philip Heckel former Chairman of the SCCS in 2008, who summarized the reasons for establishing the group in the 2008 issue of Newsletter on Carboniferous Stratigraphy [v. 26, p. 3]. Carlo Corradini is the Vice-chairman. Aretz has summarized the recent work of the group through October 2013 in this annual report and in volume 31 of the Newsletter on Carboniferous Stratigraphy, which will be published in 2014.

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@tcd.ie). Using e-mail communications from the chairman, the recent activities of the group are summarized herein through October 31st 2013.

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@canada.ca), who summarized the recent work of the group through October 31st, 2013 in volume 31 (to be published in 2014) of the Newsletter on Carboniferous Stratigraphy and herein.

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@geol.msu.ru), who summarized the recent work of the group through October 31st, 2013 in volume 31 (to be published in 2014) of the Newsletter on Carboniferous Stratigraphy and herein.

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@fukuoka-u.ac.jp). Ueno summarized the recent work of the group through October 31st, 2013 in volume 31 (to be published in 2014) of the Newsletter on Carboniferous Stratigraphy and herein.

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.

9c. INTERFACES 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.

References

ALEKSEEV, A.S. & N.V. GOREVA (2007): Conodont zonation for the type Kasimovian and Gzhelian stages in the Moscow Basin, Russia. ─ *In*: WONG, Th. (ed.), Proceedings of the XVth International Congress on Carboniferous and Permian Stratigraphy. Royal Netherlands Academy of Arts and Sciences, Amsterdam, p. 229─242.

ALEKSEEV, A.S. & N.V. GOREVA (2013): The conodont *Neognathodus bothrops* Merrill, 1972 as the marker for the lower boundary of the Stage. *In*: LUCAS, S.G., NELSON, J.W., DIMICHELE, W.A., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.), Carboniferous-Permian transition. ─ *New Mexico Museum of Natural History and Science*, Bulletin, **60**, 1─6.

ARETZ, M. (2011): Report on the workshop of the task group for defining the Devonian-Carboniferous Boundary. ─ *Subcommission on Devonian Stratigraphy Newsletter*, **26**: 18─20.

BAHAMONDE, J.R., KENTER, J.A.M., DELLA PORTA, G. & F. VAN HOEFLAKEN (2008): Facies belt of a Carboniferous carbonate platform (San Antolín-La Huelga section, NE Cantabrian Zone, northern Spain). ─ *Trabajos de Geologia*, Universidad de Oviedo, **28**: 69─86.

BARRICK, J.E., HECKEL, P.H. & D.R. BOARDMAN (2008): Revision of the conodont *Idiognathodus simulator* (Ellison 1941), the marker species for the base of the Late Pennsylvanian global Gzhelian stage. ─ *Micropaleontology*, **54**: 125-137.

BARRICK, J.E., QI, Y. & Z. WANG (2010): Latest Moscovian to earliest Gzhelian (Pennsylvanian) conodont faunas from the Naqing (Nashui) section, south Guizhou, South China. *In:* WANG, X., QI, Y., GROVES, J. BARRICK, J. NEMIROVSKAYA, T. UENO K. & Y. WANG (eds.), Carboniferous carbonate succession from shallow marine to slope in southern Guizhou. Field Excursion Guidebook for the SCCS Workshop on GSSPs of the Carboniferous System, November 21–30, 2010, Nanjing and southern Guizhou, China. ─ Nanjing Institute of Geology and Palaeontology (Chinese Academy of Sciences), 78─107.

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.

BECKER, R.T., HARTENFELS, S., ABOUSSALAM, Z.S., TRAGELEHN, H., BRICE, D. & A. EL HASSANI (2013): The Devonian-Carboniferous boundary at Lalla Mimouma (northern Maider) – a progress report. ─ *Documents de l'Institut Scientifique,* Rabat, **27**: 109─120.

BENDER, K.P. (1980): Lower and middle Pennsylvanian conodonts from the Canadian Arctic Archipelago. ─ *Geological Survey of Canada,* Paper **79**-15, 1─29.

BISCHOFF, G. (1957): Die conodonten-Stratigraphie des rheno-herzynischen Untercarbons mit Berucksichtigung der Wocklumeria-Stufe und der Devon/Karbon-Grenze. ─ *Abhandlungen des Heissischen Landesamtes für Bodenforschung*, **19**: 1─64.

BLANCO-FERRERA, S., SANZ-LÓPEZ, J. & L.C. SÁNCHEZ DE POSADA (2009): Viséan to Serpukhovian (Carboniferous) occurrences of Lochriea species at the Vegas de Sotres section (Cantabrian Mountains, Spain). ─ *Permophiles*, **53**, Supplement 1 Abstracts: 9.

BRENCKLE, P.L., LANE, H.R., RANKEY, E.C., WITZKE, B.J. & B.J. BUNKER (2005): Stratigraphy and biostratigraphy of the Mississippian Subsystem (Carboniferous) in its type region, the Mississippi River Valley of Illinois, Missouri, and Iowa. *In*: P.H. HECKEL (ed.), International Union of Geological Sciences Subcommission on Carboniferous Stratigraphy Guidebook for Field Conference, St. Louis, Missouri, September 8-13, 2001. 105 p.

CHERNYKH, V.V. CHUVASHOV, B.I., DAVYDOV, V.I., SCHMITZ, M.D. & W.S. SNYDER (2006): Usolka section (southern Urals, Russia): a potential candidate for GSSP to define the base of the Gzhelian Stage in the global chronostratigraphic scale. ─ *Geologija*, **49**: 205─217.

CORRADINI, C., BARCA, S. & C. SPALLETTA (2003): Late Devonian-Early Carboniferous conodonts from the "*Clymeniae* limestones" of SE Sardinia (Italy). ─ *Courier Forschungs Institut Senckenberg*, **245**: 227─253.

CORRADINI, C. & S.I. KAISER (2009): Morphotypes in the early *Siphonodella* lineage: implications for the definition of the Devonian/Carboniferous boundary. *In:* ICOS 2009 Calgary, July 12-17. ─ *Permophiles*, **53** (Supplement 1) Abstracts: 13.

CORRADINI, C. KAISER, S.I., PERRI, M.C. & C. SPALETTA (2010): Conodont genus *Protognathodus* as a possible tool for recognizing the Devonian/Carboniferous boundary. *In:* Third International Palaeontological Congress, IPC3, London, June 28th to July 3, 2010; Program with Abstracts, p. 131.

CORRADINI, C., KAISER, S.I., PERRI, M.C. & C. SPALLETTA (2011): *Protognathodus* (Conodonta) and its potential as a tool for defining the Devonian/Carboniferous boundary. ─ *Rivista Italiana di Paleontologia e Stratigrafia*, **117**: 15─28.

CORRADINI, C., SPALLETTA, C., KAISER, S.I. & H. MATYJA (2013): Overview of conodonts across the Devonian/Carboniferous boundary. ─ *Asociación Paleontológica Argentina, Publicación Especial*, **13**: 13─16.

CRAMER, B.D., SALTZMAN, M.R., DAY, J.E. & B.J. WITZKE (2008): Record of the Late Devonian Hangenberg Global positive carbon-isotope excursion in an epeiric sea setting: carbonate production, organic-carbon burial and paleoceanography during the late Famennian. *In*: B.R. PRATT & C. HOLMDEN (eds.) Dynamics of epeiric seas. ─ *Geological Association of Canada Special Paper* **48:** 103─118.

DAVYDOV, V.I., CHERNYKH, V.V., CHUVASHOV, B.I., SCHMITZ, M. & W.S. SNYDER (2008): Faunal assemblage and correlation of Kasimovian-Gzhelian Transition at Usolka Section, Southern Urals, Russia (a potential candidate for GSSP to define base of Gzhelian Stage). ─ *Stratigraphy*, **5**: 113-136.

DAVYDOV, V.I., CROWLEY, J.L. & SCHMITZ, M.D. (2010): High-precision U-Pb zircon age calibration of the global Carboniferous time scale and Milankovitch band cyclicity in the Donets Basin, eastern Ukraine. ─ *Geochemistry Geophysics Geosystems*, **11**(1): 1─22.

DAVYDOV, V.I., GLENISTER, B.F., SPINOSA, C., RITTER, S.M., CHERNYKH, V.V., WARDLAW, B.R. & W.S. SNYDER (1998): Proposal of Aidaralash as Global Stratotype Section and Point (GSSP) for base of the Permian System. ─ *Episodes*, **21**(1): 11-18.

DAVYDOV, V.I., KORN, D. & M.D. SCHMITZ (2012): The Carboniferous Period. *In*: GRADSTEIN, F.M., OGG, J.G., SCHMITZ, M.D. and G.M. OGG (eds.) The geologic time scale 2012. ─ Elsevier, Amsterdam, p. 603-651

DI VENERE, V.J. & N.D. OPDYKE (1990): Paleomagnetism of the Maringouin and Shepody formations, New Brunswick: a Namurian magnetic stratigraphy. ─ *Canadian Journal of Earth Sciences*, **27**: 803─810.

DI VENERE, V.J & N.D. OPDYKE (1991): Magnetic polarity stratigraphy in the uppermost Mississippian Mauch Chunk Formation, Pottsville, Pennsylvania. ─ *Geology*, **19**: 127─130.

DEVUYST, F.-X., HANCE, L., HOU, H., WU, X., TIAN, S., COEN, M. & G. SEVASTOPULO (2003): A proposed Global Stratotype Section and Point for the base of the Viséan Stage (Carboniferous). The Pengchong section, Guangxi, south China - Episodes, **26:** 105-115.

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.

ELLISON, S.P. (1941) : Revision of the Pennsylvanian conodonts. ─ *Journal of Paleontology*, **15**: 107-143.

GIBSHMAN, N.B., KABANOV, P.B., ALEKSEEV, A.S., GOREVA, N.V. & M.A. MOSHKINA (2009): Novogurovsky Quarry upper Viséan and Serpukhovian. *In*: ALEKSEEV A.S. & N.N. GOREVA (eds.)

Type and reference Carboniferous sections in the south part of the Moscow Basin. ─ *Borissiak Paleontological Institute of Russian Academy of Sciences*, August 11-12, 2009 Field Trip Guidebook, p. 13─44.

GOREVA, N.V. & A.S. ALEKSEEV (2012): Position of lower boundary of Moscovian Stage of Carboniferous Stage. Paleozoic of Russia: regional stratigraphy, paleontology, geo- and bio-events. Proceedings of 3rd All-Russian Meeting, 24 – 28 September 2012. Sankt-Petersbourg: 72─74.

GOREVA, N.V., ALEKSEEV, A.S., ISAKOVA, T.I. & O. KOSSOVAYA (2009): Biostratigraphical analysis of the Moscovian-Kasimovian transition at the neostratotype of Kasimovian Stage (Afanasievo section, Moscow Basin, Russia). ─ *Palaeoworld*, **18**: 102─113.

GROVES, J.R. (2010): Foraminifers from the Viséan-Serpukhovian and Bashkirian-Moscovian boundaries at the Nashui section, Guizhou Province, South China. *In:* WANG, X., QI, Y., GROVES, J. BARRICK, J. NEMIROVSKAYA, T. UENO K. & Y. WANG (eds.), Carboniferous carbonate succession from shallow marine to slope in southern Guizhou. Field excursion for the SCCS Workshop on GSSPs of the Carboniferous System; November 21st - 30th, 2010; Nanjing and southern Guizhou, China, 108─117.

GROVES J.R. & task group (2011): Report of the task group to establish a GSSP close to the existing Bashkirian-Moscovian Boundary. ─ *Newsletters on Carboniferous Stratigraphy*, **29**: 30─33.

GROVES, J.R., WANG, Y., QI, Y., RICHARDS, B.C., UENO, K. & X. WANG (2012): Foraminiferal biostratigraphy of the Viséan-Serpukhovian (Mississippian) boundary interval at slope and platform sections in southern Guizhou (South China). ─ *Journal of Paleontology*, **86**(5): 753─774.

HECKEL, P.H., ALEKSEEV, A.S., BARRICK, J.E., BOARDMAN, D.R., GOREVA, N.V., ISAKOVA, T.I., NEMYROVSKA, T.I., UENO, K., VILLA, E. & D.M. WORK (2008): Choice of conodont *Idiognathodus simulator* (sensu stricto) as the event marker for the base of the global Gzhelian Stage (Upper Pennsylvanian Series, Carboniferous System). ─ *Episodes*, **31**: 319─325.

HECKEL, P.H. & G. CLAYTON (2006a): Use of the new official names for the subsystems, series and stages of the Carboniferous System in international journals. ─ *Proceedings of the Geologists' Association*, **117**: 1─4.

HECKEL, P.H. & G. CLAYTON (2006b): The Carboniferous System. Use of the new official names for the subsystems, series, and stages. ─ *Geologica Acta*, **4**: 403─407.

HOUNSLOW, M.W. (2009): Report for the project group Carboniferous magnetostratigraphy. ─ *Newsletter on Carboniferous Stratigraphy*, **27**: 18─19.

HUDDLE, J.W. (1934): Conodonts from the new Albany Shale of Indiana. ─ *Bulletins of American Paleontology*, **21**(72): 1─136.

ISAKOVA, T.N. (2013): *Fusulinida* (Foraminifera) wall evolution during Bashkirian and Moscovian times of Carboniferous Period and problem of boundary of Moscovian Stage in International scale. *In*: GOZHIK, P.F. (ed.), Stratigrafiya osadochnykh obrazovaniy verkhnego proterozoya i fanerozoya. ─ *Materialy mezhdunarodnoy nauchnoy konferentsii* (Kiev, 23 – 26 sentyabrya 2013 g.). LAT&K, Kiev, 76─78.

JI, Q., WANG, Z., SHENG, H., HOU, J., FENG, R., WEI, J., WANG, S., WANG, H., XIANG, L. & G. FU (1989): The Dapoushang section an excellent section for the Devonian-Carboniferous Boundary stratotype in China. ─ *Science Press*, Beijing, China, 148 p.

JOHNSTON, D.I., HENDERSON, C.M. & M.J. SCHMIDT (2010): Upper Devonian to Lower Mississippian conodont biostratigraphy of uppermost Wabamun Group and Palliser Formation to lowermost Banff and Lodgepole formations, southern Alberta and southeastern British Columbia, Canada: Implications for correlations and sequence stratigraphy. ─ *Bulletin of Canadian Petroleum Geology*, **58** (4): 295─341.

KABANOV, P. & A.S. ALEKSEEV (2011): Progress in cyclothem/sequence stratigraphy of type Lower Moscovian succession of Moscow Basin, Russia. ─ *Newsletter on Carboniferous Stratigraphy*, **29**: 42─50.

KABANOV, P.B., ALEKSEEVA, T.V. & A.O. ALEKSEEV (2012): Serpukhovian Stage (Carboniferous) in the type area: sedimentology, mineralogy, geochemistry, and section correlation. ─ *Institute of Physical, Chemical, and Biological Problems of soil Science, Russian Academy of Sciences,* Pushchino, Russia, **20**: 18─48.

KABANOV, P.B., ALEKSEEV, A.S., GABDULLIN, R.R., GIBSHMAN, N.B., BERSHOV, A., NAUMOV, S., & E. SAMARIN (2013): Progress in sequence stratigraphy of upper Viséan and lower Serpukhovian of southern Moscow Basin, Russia. ─ *Newsletter on Carboniferous Stratigraphy*, **30**: 55─65.

KABANOV, P.B., GIBSHMAN, N.B., BARSKOV, I.S., ALEKSEEV, A.S. & N.V. GOREVA (2009): Zaborie section lectostratotype of Serpukhovian Stage. *In*: S. ALEKSEEV & N.N. GOREVA (eds.) Type and reference Carboniferous sections in the south part of the Moscow Basin. ─ *Borissiak. Paleontological Institute of Russian Academy of Sciences,* August 11-12, 2009 Field Trip Guidebook, p. 45─64.

KAISER, S.I. (2005): Mass extinction, climatic change and oceanographic changes at the Devonian-Carboniferous boundary. ─ Ph.D. Thesis, Ruhr-Universität Bochum, Germany, 156 p. (unpublished).

KAISER, S.I. (2009): The Devonian/Carboniferous boundary stratotype section (La Serre, France) revisited. ─ *Newsletters on Stratigraphy*, **43**: 195─205.

KAISER, S.I. & C. CORRADINI (2011): The early siphonodellids (Conodonta, Late Devonian-Early Carboniferous): overview and taxonomic state. ─ *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **261/1**: 19─35.

KAISER, S.I., STEUBER, T. & R.T. BECKER (2008): Environmental change during the Late Famennian and Early Tournaisian (Late Devonian-Early Carboniferous): implications from stable isotopes and conodont biofacies in southern Europe. ─ *Geological Journal*, **43**: 241─260.

KORN, D. & A.L. TITUS (2011): *Goniatites* Zone (Middle Mississippian) ammonoids of the Antler Foreland Basin (Nevada, Utah). ─ *Bulletin of Geosciences*, **86** (1): 107─196.

KOZITSKAYA, R.I., KOSENKO, Z.A., LIPNYAGOV, O.M. & T.I. NEMIROVSKAYA (1978): Carboniferous conodonts of Donets Basin. ─ *Kiev: Naukova dumka*, 134 p.

KULAGINA, E.I., PAZUKHIN, V.N, & V.I. DAVYDOV (2009): Pennsylvanian biostratigraphy of the Basu River section with emphasis on the Bashkirian-Moscovian transition. *In*: PUCHKOV, V.N., KULAGINA, E.I., NIKOLAEVA, S.V. & N.N. KOCHETOVA (eds.). Carboniferous type sections in Russia and potential global stratotypes. Proceedings of the International Field Meeting "The historical type sections, proposed and potential GSSPs of the Carboniferous in Russia." Southern Urals Session. Ufa—Sibai, 13–18 August, 2009. ─ *Ufa-DesignPolygraphService, Ltd*., 34─63.

LANE, H.R., BRENCKLE, P.L., BASEMANN, J.F. & B. RICHARDS (1999): The IUGS boundary in the middle of the Carboniferous: Arrow Canyon, Nevada, USA. ─ *Episodes*, **22**(4): 272─283.

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.

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.

MAKHLINA, M.Kh., ALEKSEEV, A.S., GOREVA, N.V., GORJUNOVA, R.V., ISAKOVA, T.N., KOSSOVAYA, O.L., LAZAREV, S.S., LEBEDEV, O.A. & A.A. SHKOLIN (2001): Middle Carboniferous of Moscow Syneclise (southern part). Volume 2. Biostratigraphy. ─ *Scientific World*, Moscow, 328 p.

MALAKHOVA, N.P. (1956): Foraminifera of the limestones of the Shartymka River in the southern Urals. ─ *Akademiya Nauk SSSR, Ural'skii Filial, Trudy Gorno-Geologicheskovo Institut, vypusk 24, Sbornik po Voprosam Stratigrafii*, **3**: 72─124.

MENNING, M., ALEKSEEV, A.S., CHUVASHOV, B.I., DAVYDOV, V.I., DEVUYST, F.-X., FORKE, H.C., GRUNT, T.A., HANCE, L., HECKEL, P.H., IZOKH, N.G., JIN, Y.G., JONES, P.I., KOTLYAR, G.V.,

KOZUR, H.W., NEMYROVSKA, T.I., SCHNEIDER, J.W., WANG, X.-D., WEDDIGE, K., WEYER, D. & D.M. WORK (2006): Global time scale and regional stratigraphic reference scales of Central and West Europe, Tethys, South China, and North America as used in the Devonian-Carboniferous-Permian correlation chart 2003 (DCP 2003). ─ *Palaeogeography, Palaeoclimatology, Palaeoecology*, **240**: 318─372.

MERRILL, G.K. (1972): Taxonomy, phylogeny, and biostratigraphy of *Neognathodus* in Appalachian Pennsylvanian rocks. ─ *Journal of Paleontology*, **46**: 817─829.

MOSSONI, A., CORRADINI C. & C. SPALLETTA (2013): Famennian-Tournaisian conodonts from the Monte Taccu section (Sardinia, Italy). ─ *Asociación Paleontológica Argentina*, Publicación Especial, **13**: 85─90.

MURRAY, F.N. & J. CHRONIC (1965): Pennsylvanian conodonts and other fossils from insoluble residues of the Minturn Formation (Desmoinesian), Colorado. ─ *Journal of Paleontology*, **39**: 594─610.

NEMIROVSKAYA, T.I. (1990): Samye pozdnie predstaviteli roda *Declinognathodus* (konodonty) v pogranichnykh otlozheniyakh bashkirskogo i moskovskogo yarusov Donetskogo baseina (The last representatives of the genus *Declinognathodus* of the Donbas Carboniferous). ─ *Paleont. Zbornik*, **27**: 39─43

NEMIROVSKAYA, T., PERRET, M.F. & D. MEISCHNER (1994): *Lochriea ziegleri* and *Lochriea senckenbergica* - new conodont species from the latest Viséan and Serpukhovian in Europe. ─ *Courier Forschungsinstitut Senc*kenberg, **168**: 311─317.

NIKOLAEVA, S.V. (2013): Ammonoids from the Viséan-Serpukhovian Boundary beds in the Verkhnyaya Kardailovka section: a progress report. ─ *Newsletter on Carboniferous Stratigraphy*, **30**: 49─53.

NIKOLAEVA, S.V., AKHMETSHINA, L.Z., KONOVALOVA, V.A., KOROBKOV, V.F. & G.F. ZAINAKAEVA (2009a): The Carboniferous carbonates of the Dombar Hills (western Kazakhstan) and the problem of the Viséan-Serpukhovian boundary. ─ *Palaeoworld*, **18:** 80─93.

NIKOLAEVA, S.V., ALEKSEEV, A.S, KULAGINA, E.I., GIBSHMAN, N.B., RICHARDS, B.C., KOCHETOVA, N., GATOVSKY, Y.A., KONOVALOVA, V.A., ZAINAKAEVA, G.F., & N. FAZLIAKHMETOVA, (in press). New microfacies and fossil records (ammonoids, conodonts, foraminifers) from the Viséan-Serpukhovian boundary beds in the Verkhnyaya Kardailovka section, Russia. ─ *Newsletter on Carboniferous Stratigraphy*, **31**:

NIKOLAEVA, S.V., GIBSHMAN, N.B., KULAGINA, E.I., BARSKOV, I.S. & V.N. PAZUKHIN (2002): Correlation of the Viséan-Serpukhovian boundary in its type region (Moscow Basin) and the South Urals and a proposal of boundary markers (ammonoids, foraminifers, conodonts). ─ *Newsletter on Carboniferous Stratigraphy*, **20**:16─21.

NIKOLAEVA, S.V., KULAGINA, E.I., PAZUKHIN, V.N., KOCHETOVA, N.N. & V.A. KONOVALOVA (2009b): Paleontology and microfacies of the Serpukhovian in the Verkhnyaya Kardailovka section, south Urals, Russia: potential candidate for the GSSP for the Viséan-Serpukhovian boundary. ─ *Newsletters* on Stratigraphy, **43:** 165─193.

NIKOLAEVA, S.V., KULAGINA, E.I., PAZUKHIN, V.N., KUCHEVA, N.A., STEPANOVA, T.I., KOCHETOVA, N.N., GIBSHMAN, N.B., AMON, E.O., KONOVALOVA, V.A. & G.F. ZAINAKAEVA (2005): Advances in understanding of the Viséan-Serpukhovian boundary in the South Urals and its correlation. ─ *Newsletter on Carboniferous Stratigraphy*, **23:** 27─30.

PAPROTH, E., FEIST, R. & G. FLAJS (1991): Decision on the Devonian-Carboniferous boundary stratotype. ─ *Episodes*, **14**: 331─336.

PAPROTH, E. & M. STREEL (1984): Precision and practicability: On the definition of the Devonian-Carboniferous boundary. ─ *Courier Forschungsinstitut Senckenberg*, **67**: 255─258.

PAZUKHIN, V.N., KULAGINA, E.I., NIKOLAEVA, S.V., KOCHETOVA, N.N. & V.A. KONOVALOVA (2010): The Serpukhovian Stage in the Verkhnyaya Kardailovka Section, South Urals. ─ *Stratigraphy and Geological Correlation*, **18**: 269─289.

QI, Y. (2008): Conodont biostratigraphy of the candidate GSSPs for the base of the Serpukhovian Stage and Moscovian Stage in the Naqing (Nashui) section, Luosu, Luodian, Guizhou, South China. ─ Doctoral thesis of the Graduate University of Chinese Academy of Sciences, p. 1─157, 25 pls.

QI, Y.P., BARRICK, J.E. & K.Y. HU (2013): The *Idiognathodus turbatus* conodont lineage in the Naqing section, South China, and the base of the global Kasimovian stage. *In*: LUCAS, S.G., DIMICHELE, W., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.), The Carboniferous-Permian Transition. ─ *New Mexico Museum of Natural History and Science*, Bulletin, **60**: 328.

QI, Y., LAMBERT, L.L., BARRICK, J.E., GROVES, J.R, WANG, Z., HU, K. & X. WANG (2010): New interpretation of the conodont succession of the Naqing (Nashui) section: candidate GSSP for the base of the Moscovian Stage, Luosu, Luodian, Guizhou, South China. *In:* WANG, X. QI, Y., GROVES, J., BARRICK, J., NEMIROVSKAYA, T.I., UENO, K. & Y. WANG (eds.), Carboniferous carbonate succession from shallow marine to slope in southern Guizhou. Field Excursion Guidebook for the SCCS Workshop on GSSPs of the Carboniferous System, November 21–30, 2010, Nanjing and southern Guizhou, China. ─ *Nanjing Institute of Geology and Palaeontology (Chinese Academy of Sciences)*, 65–77.

QI, Y., LAMBERT, L.L., NEMYROVSKA, T., WANG, X.-D., HU, K., & Q. WANG (2013): Multiple transitional conodont morphologies demonstrate depositional continuity the Bashkirian-Moscovian boundary interval, Naqing section, Guizhou, South China. ─ *New Mexico Museum of Natural History*, Bulletin **60**: 329─336.

QI, Y., NEMYROVSKA, T., WANG, X., CHEN, J., WANG, Z., LANE, H.R., RICHARDS, B.C., HU, K., & Q. WANG (2013): Late Viséan-early Serpukhovian conodont succession at the Naqing (Nashui) section in Guizhou, South China. ─ *Geological Magazine* doi: 10.1017/S001675681300071X Published online by Cambridge University Press 08 October, 2013.

QI, Y. & Z. WANG (2005): Serpukhovian conodont sequence and the Viséan-Serpukhovian Boundary in South China. ─ *Rivista Italiana di Paleontologica e Stratigrafia*, **111:** 3─10.

QI, Y., WANG, X.D., WANG Z.H., LANE H.R., RICHARDS, B.C., UENO K. & R.J. GROVES (2009): Conodont biostratigraphy of the Naqing (Nashui) section in south China: candidate GSSPs for both the Serpukhovian and Moscovian stages. ─ *Permophiles*, **53**: 39─40.

QI, Y., WANG, Z.H., WANG Y., UENO, K. & X.D. WANG (2007): Stop 1: Nashui section. *In:* Pennsylvanian and Lower Permian carbonate successions from shallow marine to slope in southern Guizhou. XVI International Congress on the Carboniferous and Permian, June 21-24, 2007 Nanjing China; Guide Book for Field Excursion C3 p. 8─16.

REITLINGER, E. A. (1949): Smaller foraminifers in the lower part of the middle Carboniferous of the Middle Urals and Kama River area. ─ *Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya*, **6**: 149–164.

REITLINGER, E. A. (1956): Lasiodiscidae, a new family. ─ *Akademiya Nauk SSSR, Otdelenie Geologo-Geograficheskikh Nauk, Geologicheskiy Institut, Voprosy Mikropaleontologii*, **1**: 69–78.

RICHARDS, B.C. (2013): Current status of the Carboniferous time scale. *In*: LUCAS, S.G., DIMICHELE, W., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.), The Carboniferous-Permian Transition. ─ *New Mexico Museum of Natural History and Science*, Bulletin, **60**: 348-353.

RICHARDS, B.C., LANE, H.R. & P.L. BRENCKLE (2002): The IUGS Mid-Carboniferous (Mississippian-Pennsylvanian) Global Boundary Stratotype Section and Point at Arrow Canyon, Nevada, USA. *In*: Carboniferous and Permian of the World, HILLS, L.V. HENDERSON, C.M. & E.W. BAMBER (eds.), Carboniferous and Permian of the World. ─ *Canadian Society of Petroleum Geologists*, Memoir **19**, 802─831.

RICHARDS, B.C., NIKOLAEVA, S.V., KULAGINA, E.I., ALEKSEEV, A.S., GOROZHANIN, V.M., GOROZHANINA, E.N. & Y.A. GATOVSKY (in press): Volcanic ash and carbonate deposition in Verkhnyaya Kardailovka section, south Urals, Russia: a GSSP candidate for base of Serpukhovian. ─ *Geological Magazine*.

RICHARDS, B.C., ROSS, G.M. & J. UTTING (2002): U-Pb geochronology, lithostratigraphy and biostratigraphy of tuff in the Upper Famennian to Tournaisian Exshaw Formation: evidence for a mid-Paleozoic magmatic arc on the northwestern margin of North America. *In*: HILLS, L.V., HENDERSON, C.M. & E.W. BAMBER (eds.), Carboniferous and Permian of the World. ─ *Canadian Society of Petroleum Geologists*, Memoir **19**: 158─207.

RICHARDS, B.C. & task group (2010): Report of the joint Devonian-Carboniferous Boundary GSSP reappraisal task group. ─ *Newsletter on Carboniferous Stratigraphy*, **28**: 26─30.

ROSSCOE, S.J. & J.E. BARRICK (2009a): Revision of *Idiognathodus* species from the Desmoinesian-Missourian (Moscovian-Kasimovian) boundary interval in the Midcontinent Basin, North America. ─ *Palaeontographica Americana*, **62**: 115─147.

ROSSCOE, S.J. & J.E. BARRICK (2009b): *Idiognathodus turbatus* and other key taxa of the Moscovian-Kasimovian boundary interval in the Midcontinent region, North America. ─ *Newsletter on Carboniferous Stratigraphy*, **27**: 21─25.

ROSSCOE, S.J. & J.E. BARRICK (2013): North American species of the conodont genus *Idiognathodus* from the Moscovian-Kasimovian boundary composite sequence and correlation of the Moscovian-Kasimovian stage boundary. *In*: LUCAS, S.G., DiMICHELE, W., BARRICK, J.E., SCHNEIDER, J.W. & J.A. SPIELMANN (eds.), The Carboniferous-Permian Transition. ─ *New Mexico Museum of Natural History and Science*, Bulletin, **60**: 354─371.

SANDBERG, C.A., STREEL, M & R.A. SCOTT (1972): Comparison between conodont zonation and spore assemblages in the Devonian-Carboniferous boundary in the western and central United States and in Europe. Septième Congrès International de Stratigraphie et de Géologie du Carbonifère, Krefeld 1971. ─ *Compte Rendu*, **1**: 179─203.

SANZ-LÓPEZ, J., BLANCO-FERRERA, S., SÁNCHEZ DE POSADA, L.C. & S. GARCÍA-LÓPEZ (2007): Serpukhovian conodonts from northern Spain and their biostratigraphic application. ─ *Palaeontology*, **50**: 883─904.

SEVASTOPULO, G.D. & M. BARHAM (2013): Correlation of the base of the Serpukhovian Stage (Mississippian) in NW Europe. ─ *Geological Magazine*, doi:10.1017/S00016756813000630 published online by Cambridge University Press, p. 1─10.

SKOMPSKI, S., ALEKSEEV, A., MEISCHNER, D., NEMIROVSKAYA, T., PERRET, M.-F. & W.J. VARKER (1995): Conodont distribution across the Viséan/Namurian boundary. ─ *Courier Forschungsinstitut Senckenberg*, **188:** 177─209.

UENO, K., HAYAKAWA, N., NAKAZAWA, T., WANG, Y. & X. WANG (2007): Stop 2, Zhongdi section. *In*: Pennsylvanian and Lower Permian carbonate successions from shallow marine to slope in southern Guizhou. XVI International Congress on the Carboniferous and Permian, June 21-24, 2007 Nanjing China; Guide Book for Field Excursion C3, 8─16.

UENO, K & task group (2011): The Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries – an overview and progress report. *In*: E. HÅKANSSON, & J. TROTTER (eds.) 2011, Program & Abstracts, The XVII International Congress on the Carboniferous and Permian, Perth 3–8 July 2011: ─ *Geological Survey of Western Australia*, Record **2011/20**: 124.

VILLA, E., ALEKSEEV, A.S., BARRICK, J.E., BOARDMAN, D.R., DJENCHURAEVA, A.V., FOHRER, B., FORKE, H., GOREVA, N.V., HECKEL, P.H., ISAKOVA, T.I., KOSSOVAYA, O., LAMBERT, L.L., MARTÍNEZ-CHACÓN, M.L., MÉNDEZ, C.A., NEMYROVSKA, T.I., REMIZOVA, S., SAMANKASSOU, E., SÁNCHEZ DE POSADA, L.C., UENO, K., WAHLMAN, G. & D.M. WORK (2009): Selection of the conodont Idiognathodus simulator (Ellison) as the event marker for the base of the global Gzhelian Stage (Upper Pennsylvanian, Carboniferous). ─ *Palaeoworld*, **18**: 114─119.

VILLA, E. & Task Group (2008): Progress report of the task group to establish the Moscovian-Kasimovian and Kasimovian-Gzhelian boundaries. ─ *Newsletter on Carboniferous Stratigraphy*, **26**: 12─13.

WANG, Z. & Y. QI (2003): Upper Carboniferous (Pennsylvanian) conodonts from south Guizhou of China. ─ *Rivista Italiana di Paleontologia e Stratigrafia*, **109**: 379─397.

WU, X., JIN, X., WANG, Y., WANG, W. & Y. QI (2009): The foraminiferal assemblage in the Viséan-Serpukhovian interval at the Yashui section, Guizhou, south China. ─ *Newsletter on Carboniferous Stratigraphy*, **27:** 28─33.

ZELLER, D.E.N. (1953): Endothyroid foraminifera and ancestral fusulinids from the type Chesterian (Upper Mississippian). ─ *Journal of Paleontology*, **27**: 183–199.