



## Annual Report 2015\* of IGCP Project No. 592

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**by 01/12/2015**

**IGCP project short title: "Continental construction in Central Asia"**

**Duration: 2012-2015**

**Please tick this box if the report is for a Project on extended term (OET):**

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**1. Website address(es) related to the project**

<http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/international-geoscience-programme/igcp-projects/deep-earth/project-592/> - UNESCO-IGCP site  
<https://sites.google.com/site/igcp592/home> or <http://igcp592.igm.nsc.ru> - official IGCP#592 site  
<http://www.igm.nsc.ru/> - crosslink to the IGCP#592 site at the website of IGM SB RAS  
<http://inqua2015.jp> - website of Meeting #2, Nagoya, Japan

[www.ICCP2015.kpfu.ru](http://www.ICCP2015.kpfu.ru) – website of Meeting #3, Kazan, Russia  
<http://www.igeodata.org/handle/123456789/84> – link to the materials of Meeting #4, Beijing, China  
<http://www.iwtoma.org/user/www.iwtoma.org/en-us/> – website of Meeting #5, Wuhan, China  
<http://bm.cugb.edu.cn/iagr/updates/416691.shtml> – link to the materials of Meeting#6, Tsukuba, Japan  
<http://www.igm.nsc.ru/labs/lab212/~safonova/english/safonova-index-engl.htm> – website of Inna Safonova  
<http://www.nhm.ac.uk/cercams> - official website of the CERCAMS led by co-leader Reimar Seltnann  
<http://www.earthsciences.hku.hk/people/academic-staff/prof-sun-min> - university site of co-leader Min Sun  
<http://english.igg.cas.cn/rh/rd/dotp/> - institutional website of co-leader Wenjiao Xiao  
<http://www.rockpetrology.com/> - website of the International Workshop "From Melts To Igneous Rock", Trabzon, Turkey - an educational training event.  
<http://www.sciencedirect.com/science/journal/13679120/113/supp/P1>- IGCP-592 special issue of J. Asian Earth Sciences on "Tectonics of the CAOB and its Pacific analogues", v. 113, p. 1-542 (1 Dec 2015).  
<http://www.sciencedirect.com/science/journal/00401951/662> - Tectonophysics special issue on "Comparative tectonic and dynamic analysis of cratons, orogens, basins, and metallogeny", v. 662, p.1-480 (1 Nov 2015)

## 2. Summary of major past achievements of the project

During the previous years of 2012-2014, the IGCP-592 results addressed the following big questions: 1) evaluation of juvenile to recycled crust in the CAOB based on isotope geochronology and geochemistry; 2) geology, tectonics and magmatism in different segments of the CAOB; 3) assessment of accretion as part of continental construction; 4) metallogeny and formation of mineral deposits; 5) correlations between the CAOB and WP based on new project results; 6) contribution of deep-mantle processes to continental growth; 7) climate change and environmental impact. Geologic and lithostratigraphic comparisons of CAOB and WP showed both P- and C-type orogenic belts in the CAOB and highlight the presence of OPS units in both Phanerozoic (CAOB, WP) and Precambrian accretionary orogens, the importance of contribution of mantle plumes to crustal growth and the mechanisms of their generation. Combination of U-Pb zircon ages with Nd and Hf isotopes helped to identify juvenile crust domains in the western (Altai, Junggar, Tianshan), southern (Beishan, Dunhuang) and eastern (Inner Mongolia) CAOB and both juvenile and recycled domains in the Kyrgyz Tianshan. The timing of granitoid and mafic magmatism showed peaks in the late Neoproterozoic (mafic), Cambrian-Ordovician, Devonian and Triassic (granitoid) and suggested a late Permian closure of the PAO. Deep mantle dynamics greatly contributed to the continental construction in the CAOB through Meso-Cenozoic intra-plate continental volcanism (Junggar, Transbaikalia, Mongolia, East China) related to hydrous-carbonated plumes generated in the mantle transition zone and triggered by the oceanic subduction, tectonic erosion and arc subduction at P-type convergent margins surrounding Laurasia and Eurasia. The data on the formation ages and genesis of gold, PGE, porphyry and iron deposits contributed to the understanding of metallogenesis and evolution of the whole CAOB. The comparison with the modern WP showed that the CAOB is dominated by P-type orogenic belts as it hosts numerous localities of granitoids with juvenile isotope characteristics, blueschists derived from MORB and OIB protoliths, accreted carbonate-capped OIBs and other OPS units, huge granitoid batholiths and boninites.

## 3. Achievements of the project this year only

### 3.1. General scientific achievements

In 2015, the research activities in the frame of IGCP#592 were performed in eight main fields/topics.

#### 1) Geology, tectonics and magmatism of different segments of the CAOB:

- i) Russian-Kazakh Altai and East Kazakhstan (Chen M. et al., 2014, 2015; Kuibida et al., in press; Li et al., in press);
- ii) Junggar Region in NW China and SE Kazakhstan (Li et al., in press; Luo et al., in press; Xiao et al., 2015A; Yang et al., in press; Yin et al., in press, 2015; Zhao et al., 2015);
- iii) Kyrgyz and Chinese Tianshan (Ge et al., 2015; He et al., 2015; Klemm et al., 2015; Li et al., 2015; Scheltens et al., 2015);
- iv) southern CAOB (Ao et al., in press; Cai et al., 2015; Gillespie et al., in press; Li et al., 2015; Guy et al., 2015; Song et al., 2015; Zhao Y. et al., in press);
- v) eastern CAOB (Fu et al., in press; Li et al., in press; Zhao P. et al., in press; Zhu et al., 2015).

#### 2) Evaluation of crustal growth through zircon U-Pb ages and Hf isotopes and whole rock isotopes:

- i) formation of continental crust and timing of granitoid magmatism (Anonymous, 2015; Cai et al., 2015; He et al., 2015; Kuibida et al., in press; Kusky and Xiao, in press; Li et al., in press; Ma et al., 2015; Popov et al., 2015);
- ii) evolution of convergent margins and the timing of mafic and andesitic magmatism (Anonymous, 2015; Fu et al., in press; Ge et al., 2015; Li et al., in press; Zhao et al., 2015);
- iii) juvenile vs recycled granitoid magmatism (Ma et al., 2015; Safonova et al., in press, c; Yin et al., in press; Zhao et al., 2015; Wang et al., 2015),
- iv) provenance analysis of metasediments (Anonymous, 2015; Ao et al., in press; Chen M. et al., 2014, 2015; Ershova et al., 2015; Zhao P. et al., in press; Wang et al., 2015);
- v) timing of deformation and metamorphism (Anonymous, 2015; Gillespie et al., in press; Li et al., in press; Zhao Y. et al., in press; Zhu et al., 2015).

#### 3) Contribution of mantle plumes and/or intra-plate magmatism to continental growth

- i) Deep-mantle dynamics (Safonova et al., 2015; Tsunogae et al., 2015);

- ii) Intra-plate plume-related magmatism (Safonova et al., 2015, in press, a-b; Yang et al., in press; Yin et al., in press; Tsunogae et al., 2015).
- 4) *Ocean Plate Stratigraphy, ophiolites and Pacific-type orogeny*
  - i) Pacific-type orogeny (Ao et al., in press; Kusky and Xiao, in press; Safonova et al., 2015, in press, a, d; Song et al., 2015; Xiao et al., 2015A,B);
  - ii) Ocean Plate Stratigraphy (Safonova et al., in press, a, b; Nurgaliev et al., 2015; Wang et al., 2015).
  - iii) Ophiolites: ages, geochemistry and petrogenesis (Ao et al., 2015; Fu et al., in press; Luo et al., in press; Safonova et al., in press, b; Xiao et al., 2015B; Yang et al., in press)
- 5) *Reworking of CAOB crust through metamorphism and asthenosphere-lithosphere interaction:*
  - i) deformation and metamorphism at convergent margins (Gillespie et al., in press; Klemm et al., 2015; Li et al., 2015; Scheltens et al., 2015; Tian et al., in press; Zhao Y. et al., in press; Zhu et al., 2015);
  - ii) post-collisional processes (Kusky and Xiao, in press; Zhang et al., 2015; Zhao P. et al., in press; Wang et al., 2015)
  - iii) asthenosphere-lithosphere interaction beneath the CAOB (Guy et al., 2015; Kuibida et al., in press; Zhang et al., 2015)
- 6) *Metallogeny and Mineral resources of the CAOB:*
  - i) gold deposits (Dolgoplova et al., 2015; Kempe et al., 2015; Kempe et al., in press).
  - ii) major epochs of metallogenesis in the CAOB (Xiao et al., 2015A; Safonova et al., in press, d).
- 7) *Correlations between the CAOB and western Pacific* (Ershova et al., 2015; Kusky and Xiao, in press; Luo et al., in press; Safonova et al., 2015; Wang et al., 2015; Tsunogae et al., 2015)
- 8) *Links between the CAOB and Tethysides* (Ao et al., 2015; Chen Q. et al., in press; Ma et al., 2015; Moghamad et al., 2015; Tsunogae et al., 2015).

The papers of JAES Special Issue "Tectonics of the Central Asian Orogenic Belt and its Pacific Analogues" and Tectonophysics Special Issue on "Comparative tectonic and dynamic analysis of cratons, orogens, basins, and metallogeny" (see Annex 1) contributed to all the topics and regions mentioned above.

#### Major Scientific Results

1. Identification of major epochs of juvenile mafic and granitoid magmatism and evaluation of juvenile and recycled crust segments in the western CAOB (Russian-Kazakh-Chinese Altai and Junggar and Kyrgyz-Chinese Tianshan), southern CAOB (Beishan orogen, Dunhuang block) and eastern CAOB (Inner Mongolia, NE China), which showed that the early and late Palaeozoic were major period of juvenile crust formation whereas during the Middle Palaeozoic the crust was re-worked and eroded to a significant extent.
  2. The late Permian closure of the Paleo-Asian Ocean (PAO) was questioned in some regions of the CAOB. Our results suggest that it could be closed much later in the southern CAOB. However, several smaller PAO branches, i.e. Between the North and South Orogens of Inner Mongolia, could have closed earlier, in Devonian time.
  3. During the Middle Palaeozoic the Tianshan region could be a place of strong tectonic erosion of previously formed juvenile crust.
  4. Mantle plumes contributed to the continental growth in the CAOB through Meso-Cenozoic intra-plate intra-continental volcanism (SE Kazakhstan, Kyrgyzstan, NW and East China, Transbaikalia in Russia and Mongolia) related to hydrous-carbonated plumes triggered by the subduction of hydrated and carbonated oceanic crust, tectonic erosion and subduction of continental crust material and its accumulation in the mantle transition zone.
  5. Major epochs of metallogenesis in the CAOB are linked to the major shifts of tectonic regimes, e.g. the amalgamation of the whole CAOB in late Permian time (at ca. 290 Ma) was accompanied by formation of numerous gold deposits.
  6. We proposed a new approach for recognizing the origin of accreted mafic volcanic and subvolcanic rocks from accretionary complexes of P-type orogenic belts based on geological, petrologic and geochemical data. As the basalts are usually parts of accreted units of ocean plate stratigraphy (OPS), their formation in different tectonic settings, i.e., MORBs, OIBs, or IABs, can be reconstructed through a combined study of their relationships with associated sediments, initial mafic melt compositions (alkaline, tholeiitic or calc-alkaline) and geochemical features. This approach including the OPS model, which was developed in the WP and tested in the CAOB, can be successfully applied in the world largest C-type orogen, Alpine-Himalayan orogenic belt, for identification of fossil P-type belts.
  7. After the CAOB amalgamated in late Permian time, there have been three peaks of post-Permian deformations in the southern CAOB, which were induced by the Eurasia/Qiangtang (late Triassic-early Jurassic), Eurasia/Lhasa (early Cretaceous) and Eurasia/Karakorum (late Cretaceous-early Palaeogene) collisions, respectively.
- 3.2. *List of IGCP project meetings/symposia and IGCP related meetings/symposia with exact attendance (if possible) and number of countries*
1. VI Conference on isotope geochronology "Isotope dating of geological processes: new results, approaches and prospects", Institute of Precambrian Geology and Geochronology RAS, Sankt-Petersburg, Russia; June 2-5, 2015; about 300 participants\* from 14 countries.
  2. XIX INQUA Congress, session P21 "Tibetan Plateau and arid Central Asia; Nagoya Congress Centre, Nagoya, Japan, July 26-August 2, 2015; about 100\* from 18 countries.

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\* Including authors of abstracts  
Annual IGCP report

3. XVIII International Congress on the Carboniferous and Permian, session 5 "Carboniferous and Permian plate tectonics and orogenies"; Kazan Federal University, Kazan, August 11-15, 2015; ca. 30 participants from 6 countries at Session 5 (totally more than 300\* participants from more than 20 countries).
4. The First China-Russia International Meeting and IGCP 592 Workshop Institute of Geology CAGS, Beijing, China, September 23-28, 2015; about 100 participants\* from 7 countries.
5. 2<sup>nd</sup> International Workshop on Tethyan Orogenesis and Metallogeny in Asia (IWTOMA) and Silk Road Higher Education Cooperation Forum Wuhan, China, October 2015; ca. 25 participants from 6 countries at Session 5 (totally about 300 participants\* from 13 countries).
6. The 2015 IAGR Annual Convention and 12<sup>th</sup> International Symposium on "Gondwana to Asia", University of Tsukuba, Tsukuba, Japan, about 250\* participants from 21 countries.

### 3.3. Educational, training or capacity building activities related to the IGCP project and IGCP project participants.

Field training courses, schools, and lectures for young scientists have been organized in China, Russia, Japan, Kazakhstan and Turkey.

1. Joint China-Russia Seminar on the Central Asian Orogenic Belt at the University of Hong Kong, April, 2015; supervisors: G. Zhao; S. Krivonogov, Z. Liu, I. Safonova.
2. Field training courses for young scientists in the frame of Meetings#3 in Kazan (trip to Volga-Kama region, supervisor A. Sennikov); Meeting#4 in Beijing (trip to Inner Mongolia, supervisor Prof. Bei Xu), Meeting#5 in Wuhan (trip to the Dabie Mountains, supervisor Prof. Zeng) and Meeting#6 in Tsukuba (trip to the Boso accretionary mélange, supervisor Prof. Ogawa). Totally about 150 young scientists participated.
3. International Workshop on the petrology and petrogenesis of igneous rocks "From Melt to Igneous Rock" in Trabzon with a wide focused audience of under- and post-graduate students and early career scientists. The program included 23 lectures by 11 world leading scientists.
4. Joint Russian-Chinese field expedition to Aldan, 14-21 August 2015. The trip visited world-class Au, Cu, U deposits of Kuranach and Elkon and was attended by 12 scientists from Russia, China and UK.
5. 12<sup>th</sup> International scientific conference, Oskemen (Kazakhstan), 20-23 May 2015, attended by 150 participants from 12 countries with 4 volumes of proceedings, including more than 30 papers by PhD students and early career scientists. The event was accompanied by a 3-day PhD training seminar of eight Kazakhstani PhD students from EKSTU Oskemen, delivered by their UK-based mentors Dr. A. Dolgoplova and Prof. R Seltmann.

### 3.4. List of their UK countries involved in the project (\* - active this year):

Algeria\*, Australia\*, Austria, Bangladesh\*, Belgium\*, Botswana, Brazil, Canada\*, Chile, China\*, Croatia\*, Cote d'Ivoire, Czech Republic, Denmark, Egypt\*, Ethiopia, Finland\*, France\*, Germany\*, Hungary\*, Iceland\*, India\*, Indonesia\*, Iran\*, Ireland, Israel\*, Italy, Japan\*, Kazakhstan\*, Kyrgyzstan\*, Madagascar\*, Malaysia, Mongolia\*, Morocco, Mozambique\*, Myanmar\*, Nepal\*, Netherlands, New Zealand, Norway\*, Poland, Republic of Korea\*, Romania, Russia\*, South Africa\*, Spain\*, Sri Lanka\*, Sweden\*, Switzerland, Taiwan\*, Tajikistan, Thailand\*, Turkey\*, UK\*, Ukraine, USA\*, Uzbekistan\*, Vietnam\* (totally 56 countries).

### 3.5. Participation of scientists from developing countries, and in particular young and women scientists: exact number and please describe how this project specifically benefited women scientists, young scientists and/or scientists from developing countries

	Total number of scientists	Number of male scientists	Number of female scientists
Number of participating scientists	324	277	48
Number of young scientists/students (<35 years old)	96	72	14
Number of scientists from developing countries	198	177	21

### 3.6. List of the 5 most important publications (including maps) of this year a) could not have been published were it not for this project

1. Kempe, U., Graupner, T., Seltmann, R., de Boorder, H., Dolgoplova, A., Zeylman van Emmichoven, M., The Muruntau gold deposit (Uzbekistan) - a unique ancient hydrothermal system in the Southern Tien Shan, *Geoscience Frontiers* (2015), <http://dx.doi.org/10.1016/j.gsf.2015.09.005>.
2. Safonova, I., Biske, G., Romer, R.L., Seltmann, R., Simonov, V., Maruyama, S. (in press, B). Middle Paleozoic mafic magmatism and ocean plate stratigraphy of the South Tianshan, Kyrgyzstan. *Gondwana Research* (2015), <http://dx.doi.org/10.1016/j.gr.2015.03.006>.
3. Safonova, I., Maruyama, S., Litasov, K. (in press, C) Generation of hydrous-carbonate plumes in the mantle transition zone linked to tectonic erosion and subduction. *Tectonophysics* 662, 454-471.
4. Xiao W., Kusky T., Safonova I., Seltmann R., Sun M., 2015. Tectonics of the Central Asian Orogenic Belt and its Pacific Analogues, p. 1-6.

- Xiao, W., Sun, M., Santosh, M., 2015. Continental reconstruction and metallogeny of the Circum-Junggar areas and termination of the southern Central Asian Orogenic Belt. *Geoscience Frontiers*, 6, 137-140.

*b) related to this project*

- Guy A., Schulmann K., Janoušek V., Štípská P., Armstrong R., Belousova E., Dolgoplova A., Seltmann R., Lexa O., Jiang Y., Hanžl P., 2015. Geophysical and geochemical nature of relaminated arc-derived lower crust underneath oceanic domain in southern Mongolia. *Tectonics* 34, doi:10.1002/2015TC003845.
- Safonova I., Maruyama, S., Kojima S., Komiya T., Krivonogov S., Koshida K. (in press, A). Recognizing OIB and MORB in accretionary complexes: a new approach based on ocean plate stratigraphy, petrology, and geochemistry. *Gondwana Research* (2015), <http://dx.doi.org/10.1016/j.gr.2015.06.013>.
- Song D., Xiao W., Windley B.F., Han C., Tian Z., 2015. A Paleozoic Japan-type subduction-accretion system in the Beishan orogenic collage, southern Central Asian Orogenic Belt. *Lithos* 224–225, 195–213
- Xiao, W., Windley, B.F., Sun, S., Li, J., Huang, B.C., Han, C.M., Yuan, C., Sun, M., Chen, H.L., 2015. A tale of amalgamation of three collage systems in the Permian-Middle Triassic in Central Asia: Oroclines, sutures and terminal accretion. *Annual Review of Earth and Planetary Sciences*, 43, 477-507, doi: 10.1146/annurev-earth-060614-105254.
- Gillespie J., Glorie S., Xiao W., Zhang Z., Collins A.S., Evans N., McInnes B., De Grave J., in press. Mesozoic reactivation of the Beishan, southern Central Asian Orogenic Belt: Insights from low-temperature thermochronology. *Gondwana Research* (2015), <http://dx.doi.org/10.1016/j.gr.2015.10.004>.

For the full bibliography of this year see <https://sites.google.com/site/igcp592/publications> .

### 3.7. Activities involving other IGCP projects, UNESCO, IUGS or others

- Participants of IGCP Project #592 (Continental construction in Central Asia) and IGCP Project #628 (The Gondwana Map Project) co-chaired several sessions and discussions at the 12<sup>th</sup> International Symposium on “Gondwana to Asia” (Meeting #6 in Tsukuba).
- IGCP#592 together with IGCP 600 (Metallogenesis of Collisional Orogens) and 649 (Diamonds and Recycled Mantle) participated in the organization of Meeting#5 in Wuhan (October 2015, Wuhan, China) as three separate sessions.
- IGCP#592 together with IGCP#630 (Permian-Triassic climatic and environmental extremes) participated in the organization of Meeting#3 in Kazan.
- Several IGCP-592 project members participate also in activities of IGCP#599 “The Early Earth” and IGCP#596 (Paleozoic biodiversity).
- Joint publications as contributions to IGCP projects 592, 628 and 648 (Supercontinent cycles) (e.g., Gillespie et al., in press)
- The IGCP#592 activities involved the programs of the International Association of Sedimentologists (Meeting #3 in Kazan); CERCAMS (Meeting #4 in Beijing); National Science Foundation of China (Meeting #5 in Wuhan); and IAGR (Meeting #6 in Tsukuba).

### 3.9. What tangible improvements has your project obtained? (Besides publications, we are interested to hear about improvements to research, scientific contacts, policy implications, etc)

The project has improved through widened cooperative research network (§3.4, 3.5), joint seminars and training modules (§ 3.2, 3.3), career promotion, and joint field works. See <http://igcp592.igm.nsc.ru>.

### 3.10. What kinds of activities in respect to the benefit of society and science outreach has your project undertaken?

The social benefits result from i) the wide attendance of IGCP#592 linked meetings by young scientists; ii) focused resource studies to understand better formation of mineral deposits and social needs; iii) climate change and human hazard related studies, and iv) field and lab training programs for young scientists (§ 3.3). Scientists from developing countries, young and females scientists, project participants, benefited from direct meeting attendance support (§ 7), university seminars on CAOB and WP (§ 3.3), field courses and lecture courses on mineral deposits (§ 3.2, 3.3), which all constitute a major social impact.

### 3.11. What kind of public information (media reports, etc) has your project generated? And how do you evaluate their impact?

- An interview of project participant Prof. S. Krivonogov in “Science in Siberia” (no. 23 of November 19, 2015, p.) newspaper who shared his experience and results of research activities on recent sedimentation, climate and environmental changes linked to the recent tectonics of the CAOB. ([http://www.sbras.ru/HBC/images/2015/n23/nvs\\_23\\_color.pdf](http://www.sbras.ru/HBC/images/2015/n23/nvs_23_color.pdf)).
- An interview of Project Leader Inna Safonova about our IGCP#592 Project “Science in Siberia” (no. 26 of December 3, 2015) who told about the project from its scientific background and application to the outstanding results we have achieved (<http://www.sbras.info/articles/sciencestruct/mne-khotelos-chtoby-nashi-zadachi-i-dostizheniya-byli-ponyatny-ne-tolko-geolo>).
- Advertisement of IGCP#592-linked events at the GR website: <http://www.sciencedirect.com/science/article/pii/S1342937X14003165>
- Cross-links at the websites of IGCP, IGCP#592, IGM SB RAS, CERCAMS and IAGOD.

Project materials, conference proceedings, photos and related publications all are available either at <http://igcp592.igm.nsc.ru> or at <https://sites.google.com/site/igcp592/>, or upon request to [igcp592@gmail.com](mailto:igcp592@gmail.com) or to [inna@igm.nsc.ru](mailto:inna@igm.nsc.ru).