The Val gabbro plutonic suite, Kerguelen Archipelago: Evolution of a volcanic feeder system in an oceanic island

James S. Scoates[1], Dominique Weis[1], Matthias Franssens[2], Nadine Mattielli[2], Heidi Annell[1], Frederick A. Frey[3], Kirsten Nicolaysen[4] and André Giret[5]

[1]Earth & Ocean Sciences, University of British Columbia, Vancouver, BC, V6T-1Z4, Canada (jscoates@eos.ubc.ca)
[2]DSTE, Université Libre de Bruxelles, Brussels, Belgium
[3]EAPS, MIT, Cambridge, MA 02139, USA
[4]Geology, Kansas State Univ, Manhattan, KS 66505, USA
[5]Université Jean Monnet, Saint-Etienne, France

The petrology, composition and Sr-Nd-Pb-Hf isotopic geochemistry of basic and felsic rocks from the Val gabbro plutonic suite on the Kerguelen Archipelago constrain differentiation processes in sub-volcanic magma chambers and the role of variable magma flux rates in the formation of a major oceanic island. The 4 km^2 Val gabbro was forcefully emplaced at 24.25 ± 0.15 Ma (U-Pb zircon) into volcanic rocks of the Lower Miocene series on the Southeast Province. Cumulate gabbroic rocks are the dominant lithology, with horizontally layered olivine- and clinopyroxene-rich peridotitic cumulates at the base, overlain by coarse-grained olivine and/or clinopyroxene-rich gabbros and vertically layered finer grained equigranular gabbros. The Val gabbro was formed by repeated injections of crystal-rich and crystal-poor magmas into a magma reservoir where the main differentiation process was the segregation of earlier crystallized, dense mafic crystals. Striking geochemical similarities between the fine-grained intrusive rocks from the Val gabbro and the mildly alkalic basalts of the Lower Miocene series indicate that they were all derived from similar alkalic basaltic parental magmas that reflect the enriched Kerguelen mantle plume component. Prior to 25 Ma, magma flux rates associated with formation of the transitional flood basalts on the Kerguelen Archipelago were sufficiently high to prevent the establishment of sub-volcanic magma chambers capable of undergoing significant differentiation. At 25 Ma, the change to mildly alkalic basaltic volcanism was associated with deeper melting (garnet peridotite), lower extents of melting, and a lower total magma flux rate, which led to the formation and stabilization of high-level intrusions such as the Val gabbro plutonic suite.

New (U-Th)/He age constraints on the emplacement of kimberlite pipes in north-eastern Kansas

T. Blackburn[1], D. Stockli[1], R.W. Carlson[2], P. Berendson[3], J.D. Walker[1] and N.D. Winters[1]

[1]1475 Jayhawk Blvd Lawrence Rm 120 Lawrence, KS 66045 (terrenceb@ku.edu, stockli@ku.edu, jdwalker@ku.edu, ndwjhawk@ku.edu)
[2]Department of Terrestrial Magnetism, Carnegie Institution of Washington 5241 Broad Branch Road, NW Washington, DC 20015-1305 (carlson@dtm.ciw.edu)
[3]Kansas Geological Survey, 1930 Constant Ave., Lawrence, KS 66047-3726, KS 66045 (pieterb@kgs.ku.edu)

Twelve kimberlite pipes, identified by geological and geophysical exploration, are located above the mid-continent rift system in Riley and Marshall Counties, Kansas. Previous geochronological work on these rocks has yielded inconclusive estimates for their age. This study presents new data about kimberlite emplacement suing (U-Th)/He dating of apatite, titanite, and zircon from the Stockdale, and Tuttle kimberlites. Zircon from the Tuttle pipe and titanite from the Stockdale pipe give cooling ages of 105 ± 10Ma and 101 ± 15Ma respectively. These data are consistent with our Rb-Sr analysis of phlogopite megacrysts that give a 5 point isochron age of 106.5 ± 3.8Ma. This demonstrates that (U-Th)/He thermochronometry provides reliable timing constraints on the cooling of common xenocrystic phases. Apatite (U-Th)/He ages range from 67.3 ± 5Ma for the Stockdale pipe to 61.2 ± 8Ma for the Leonardville pipe, suggesting a thermal pulse in latest Cretaceous to earliest Tertiary time. Fuid-inclusion data from calcite-magnetite veins cross-cutting the kimberlites records fluid temperatures of ~150-200°C (above apatite, but below zircon/titanite closure). Apatite (U-Th)/He analyses from nearby sandstones give Jurassic cooling ages, demonstrating that there was no regional thermal event after kimberlite emplacement. These observations, coupled with (U-Th)/He and Rb-Sr age data, suggest that the kimberlites were emplaced at ~105 Ma and subjected to local reheating by fluids at ~65 Ma.

Isotopic geochemistry of the Arsentyev gabbro-syenite massif

R.A. BADMATSYRENOVA AND D.A. ORSOEV

Geological Institute SD RAS, Ulan-Ude, Russia
(brose@gin.bsc.buryatia.ru)

The Arsentyev massif is confined to the intrusions of syenite-pyroxenite-gabbro formation of high titanium ultramafic-mafic association. These intrusions are related to rift-like structures of various ages and close to alkaline basalts by geochemical characteristics. The two intrusive phases, each of them being followed by formation of the dike complex rocks, form the Arsentyev massif (Badmatsyrenova et al., 2004). The first phase consists of the stratified series of pyroxenite, olivine and kersutite gabbros, gabbros, anorthosites and syenite. The second phase includes the rocks of alkali- feldspar syenite series. The coarse-grained alkaline syenites of II phase have resemblance to similar rocks Bichursky complex MZ.

Isotopic composition of gabbro and syenite of I phase were studied. The isochron lines one gave an age of 270-280 Ma with $^{87}Sr/^{86}Sr$ initial ratios from 0.70433 up to 0.70575. Isotopic characteristic are close to high-aluminous island-arc basalts (εNd = +6- -2). The age of II phase syenites was determined by four whole-rock samples and monomineral separates (four fractions of feldspar). The isochron lines for syenite samples and mineral separates gave an age of 240 Ma with $^{87}Sr/^{86}Sr$ initial ratios from 0.70649 up to 0.71006.

The study of oxygen isotopic composition of monomineral samples shows that clinopyroxene and early hornblende from gabbro are characterized by the low values $\delta^{18}O$ (5,5-5,8 ‰) that testifies about mantle source parental mantle melt and absence a contamination by crustal material. Magnetites from disseminated and net-textured ores have low values $\delta^{18}O$ (2,4-2,7 ‰) indicated the mantle nature of the ore-magmatic system, genetic relationship and liquid immiscibility of ore-oxide and silicate melts, probably, in intermediate magma chamber.

Acknowledgement

Reference

Badmatsyrenova R.A., Orsoev D.A. (2004) Proc. IAGOD Conf., 407-410

Mantle input event in southeastern China at late Jurassic: Evidence from high ε_{Nd} granitoids

JIANGFENG CHEN AND XINSHENG GUO

School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China
(cjf@ustc.edu.cn)

Among numerous Mesozoic granitoids in southeastern China, two groups of granitoids with high $\varepsilon_{Nd}(T)$ values are identified.

The first group occurrs in (alkaline gabbro)-syenite-granite complexes, showing shoshonitic affinity. They occur along northeast striking faults. These granitoids give positive $\varepsilon_{Nd}(T)$ values, identical to or slightly lower than that of the associated mafic and syenitic rocks. They are differeciates from melts directly derived from the enriched mantle or from the newly formed mafic lower crust.

The second group includes granitoids located in so-called "Shi-Hang" zone (Gilder et al., 1996), or low Nd model age zones (Chen et al., 1998), both coicide with deep faults represented by gravity gradient zones. These granitoids possess higher $\varepsilon_{Nd}(T)$ values ranging from -1 to -7, but, share many geochemical characteristics with granites outside the zones and having "normal $\varepsilon_{Nd}(T)$ values" of -7 to -10. High $\varepsilon_{Nd}(T)$ granites of this grup are formed by the partial melting of the mixture of newly formed mantle-derived lower crust and old crustal materials, followed by strong differentiation.

The two groups of high $\varepsilon_{Nd}(T)$ granitoids are both 150 to 160 Ma in age based on zircon SHRIMP U-Pb, Rb-Sr and $^{40}Ar-^{39}Ar$ dating.

All these high $\varepsilon_{Nd}(T)$ granitoids reflect an extentional tectonic environment and represent an addition of the mantle derived meterials to the crust of the southeatern China at the late Jurassic. Distribution of these rocks along northeast striking faults suggests that Circum-Pacific tectonics was dominant by that time.

References

Gilder et al., (1996). *J. Geophys. Res.*, 101: 16137-16154
Chen et al., (1998). *Tectonophysics*, 284: 101-133

Early Archaean carbonaceous material from the Pilbara, Western Australia: Its nature, characteristics and possible sources

L.J. DUCK, M. GLIKSON, S.D. GOLDING AND R.E. WEBB

Earth Sciences, The University of Queensland, QLD, 4072, Australia (l.duck@earth.uq.edu.au)

The c. 3.49 Ga Dresser Formation, a lower member of the Warrawoona Group in the North Pole Dome region, Western Australia, is a barite/black chert dominated, mafic volcanic hosted, shallow water (<100m), seafloor exhalative hydrothermal deposit [1]. Carbonaceous matter (CM) aggregates, varying in size from 1μm to >20μm, have been isolated from black cherts in drill core from the Dresser Mine area.

With total organic carbon (TOC) contents from 0.19% to 0.31%, organic petrology and SEM-EDS studies of whole rock samples reveals the CM as aggregated forms around siliceous nuclei in the majority of samples. Transmission electron microscopy (TEM) of carbonaceous concentrates show this aggregate material to be composed of sub-micron sized granular-textured particulates. The observed morphology is suggestive of the remains of microbial clusters or colonies. TEM investigation of one sample, however, showed it to be dominated by soot particles such as have been reported from the Sudbury impact [2] and K-T boundary [3]. The presence of soot particles supports previous evidence of meteoritic impact in the Pilbara during the early Archaean [4]. Reflectance measurements (%Ro) of the CM have yielded three dominant groupings: 1) 0.5-1.5; 2) 2.4-2.8; and 3) 3.2-3.8. Different Ro populations in a single sample record several hydrothermal events, as well as relative proximity to a venting source.

These results, combined with the bulk C-isotope values of the CM (δ^{13}C -32.1 to -38.2‰ PDB, n=11), are suggestive of a biogenic source, and as such, may represent remnants of some of the earliest primitive life forms on Earth.

References

[1] Nijman, W., et al., 1999, *Precam. Res.*, **95**: 247-274.
[2] Bunch, T.E., et al., 1999, *Special Paper - Geol. Soc. Am.*, **339**: 331-343.
[3] Wolbach, W.S., et al., 1985, *Science*, **230**(4722): 167-170.
[4] Byerly, G.R., et al., 2002, *Science*, **297**(5585): 1325-1327.

Fractionation of carbon isotopes in biosynthesis of piezophilic bacteria

JIASONG FANG[1], OLIVIA CHAN[1], MARIA UHLE[2], DOUGLAS BARTLETT[3] AND CHIAKI KATO[4]

[1]Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011, USA (jsfang@iastate.edu)
[2]Department of Earth and Planetary Sciences, University of Tennessee, 306 Geological Sciences Bldg, 1412 Circle Drive, Knoxville, TN 37996, USA (muhle@utk.edu)
[3]Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Drive, La Jolla CA, 92093, USA (dbartlett@ucsd.edu)
[4]Research Program for Marine Biology and Ecology, Extremobiosphere Research Center, JAMSTEC 2-15 Natsushima-cho, Yokosuka 237-0061, Japan (kato_chi@jamstec.go.jp)

Understanding the lipid biochemistry and carbon isotope fractionation of deep-sea piezophilic bacteria is of paramount importance because lipids and stable carbon isotopes are used extensively in marine biogeochemistry for defining the sources of organic matter and assessing preservation of organic matter in ocean sediments. However, our current understanding of microbial lipid biochemistry and carbon isotope fractionation is based on studies on lipid biosynthesis of surface bacteria at warm temperature and atmospheric pressure. The models and parameters of carbon isotope fractionation derived from surface bacteria may be significantly different from that of deep-sea piezophilic bacteria. In this study, we investigated carbon isotope fractionation in a piezophilic bacterium *Moritella japonica* DSK1. DSK1 was grown in natural seawater on glucose at atmospheric pressure (atm), 100, 200, and 500 atm. Phospholipid fatty acids were extracted and identified by GC-MS. δ^{13}C of individual fatty acids was determined by a GC-C-IRMS. Fatty acids detected include C_{12-20} saurated, monounsaturated and polyunsaturated fatty acuds. The fatty acids exhibited distinctly different isotopic composition. Fatty acids from cells grown at higher pressure were considerably depleted in ^{13}C. For example, fatty acids from cells grown at 100 atm displayed remarkably less negative δ^{13}C values (8.4 to 23.2‰), whereas fatty acids of cells grown at 200 and 500 atm showed much less variations (0.2 to 4.8‰). Our results suggest that hydrostatic pressure is an important factor in influening carbon isotope fractionation in marine bacteria and that caution must be exercised in using δ^{13}C of fatty acids to determine the soiurce of organic matter in marine environment.

Eruptive source of volcanic ash in Jurassic Morrison Formation suggested by Pb isotopic composition of sanidine

GARRET L. HART[1], ERIC H. CHRISTIANSEN[2]
AND BART J. KOWALLIS[2]

[1]Department of Geology, Washington State University, Pullman, WA 99164 (ghart@wsu.edu)
[2]Department of Geology, Brigham Young University, Provo, UT 84602 (eric_christiansen@byu.edu, bart_kowallis@byu.edu)

The Late Jurassic Morrison Formation (famuous for its diverse dinosaur fossils and as a source of uranium ore), underlies a large area of the western interior of the United States. It was deposited deposited in a variety of terrestrial and lacustrine environments east of a magmatic arc along the western boundary of North America. As a result, much of the formation (particularly the Brushy Basin Member on the Colorado Plateau) consists of pyroclastic fall deposits erupted from volcanoes to the west of its outcrop belt. As such, the Morrison Formation provides an important record of Mesozoic magmatic activity along the western North American plate boundary. However, the exact locations of the pyroclastic eruptions are debated, and thus are not able to constrain tectono-magmatic models during the Mesozoic. In an effort to constrain the eruptive sources of pyroclastic deposits, we have analyzed Pb isotope ratios of sanidine separated from three samples of the Morrison Formation. To check for homogeneity and reproducibility, several subsamples of different weights were analyzed. In an individual sample, almost all of the ratios overlap at the 2-sigma error level—even for samples as small as 10 mg (10s of grains). When all three Pb isotope ratios are considered, each sample is uniform, but distinct from the other samples. This is consistent with a lack of xenocrysts or detrital contaminants in the ash. The Pb isotope compositions of two of the beds plot in Zartman's (1974) lead isotope province 2 and one lies very close to the boundary between provinces 1 and 2. There are only a few plutons in these provinces (in southern Arizona-New Mexico and in southern California) that are currently known to have Late Jurassic ages. Consequently, future research should focus on magmatic centers in these provinces as potential eruptive sources for pyroclastic beds in the Morrison Formation, and tectono-magmatic models for the Late Jurassic need to include a period of significant magmatic activity in southern California and western Arizona during the Mesozoic.

Trace element and oxygen isotope zonations in growth sectors of natural quartz crystals

A-L. JOURDAN[1], T.W VENNEMANN[1] AND J. MULLIS[2]

[1]Institut de Minéralogie et Géochimie, Université de Lausanne, CH-1015 Lausanne, Switzerland (Anne-Lise.Jourdan@unil.ch)
[2]MPI, Universität Basel, CH-4056 Basel, Switzerland

It is generally accepted that there is a structural control on trace element incorporation into crystals. By analogy, isotopic fractionation between fluid and a growing crystal surface may also occur. With the aim of examining the processes that govern mineral-fluid oxygen isotope fractionation at low to medium temperatures (150 to 350°C) in natural systems, variations in trace element and oxygen isotope compositions across and along different growth zones and sectors are being investigated in natural quartz crystals formed in veins during retrograde regional Alpine metamorphism.

$\delta^{18}O$ values measured for different parts of single crystals (center and rims; bottom and top parts) during a preliminary study were found to differ by close to 3‰ (values between 3.6 and 6.2‰). Similarly, Onasch and Vennemann (1995) have measured differences in $\delta^{18}O$ values of up to 2‰ in different sectors of the same growth zone in sector-zoned quartz crystals, opening up the possibility of fluid-mineral disequilibrium partitioning of oxygen isotopes.

Growth and sector zoning in the Alpine quartz crystals studied are highlighted using cathodoluminescence. Several profiles, selected on the basis of their cathodoluminescent appearance, had significant variations in Al, Fe, and Mg, detected using an electron microprobe. Most notable are changes in Al content that reach 100's ppm, with maxima of about 500 ppm in distinct growth zones. LA-ICPMS analyses indicated locally high concentrations of K, Ca, Ge, Li, Ti, Zr in some crystals but these anomalies could not be correlated to distinct growth zones. Additional analyses of oxygen isotope and trace element (Li, Ge, K,…) variations are planned using an ion microprobe as well as UV-Laser based *in-situ* measurements, in order to augment the data base and ultimately obtain information on growth mechanisms and their possible controls on elemental and isotopic fractionation processes for natural crystals.

Reference
Onasch C.M. and Vennemann T.W., (1995), *Geology*, 23, 1103-1106.

Nd isotopic characteristics of the South and North Liaohe Groups and tectonic implications

SANZHONG LI[1], GUOCHUN ZHAO[2], MIN SUN[2], ZHONGZHU HAN[1] AND GUANGTAO ZHAO[1]

[1]College of Marine Geology, Ocean University of China (Sanzhong@mail.ouc.edu.cn)
[2]Department of Earth Sciences, The University of Hong Kong

The Liaohe Group is an important Paleoproterozoic stratigraphic unit in the northeastern part of the North China Craton and traditionally is subdivided into the North and South Liaohe Groups. Associated with both the North and South Liaohe Groups are voluminous Paleoproterozoic granitoid rocks, named the Liaoji granitoids. Different tectonic models, including terrane amalgamation, continent-arc collision and rift closure, have been proposed to interpret the tectonic setting and evolution of the North and South Liaohe Groups and associated Liaoji granitoids. At the centre of the controversy between these models is whether or not the North and South Liaohe Groups developed on the same Archean basement. Nd isotopic geochemistry of the Liaoji granitoids provides important constraints on this controversial issue. The Liaoji granitoids associated with the North and South Liaohe Groups display similar εNd values, restricted to a narrow range from 0 to 2, implying that these granitoid rocks were derived from the same or a similar magma source. Moreover, the Liaoji granitoids associated with the North and South Liaohe Groups have similar Nd model age (TDM), ranging from 2.4 Ga to 2.6 Ga, suggesting that the protoliths of the Liaoji granitoids associated with both the groups may have formed simultaneously, and that the basement rocks underneath the Liaoji granitoids and associated North and South Liaohe Groups belong to the same continental block rather than two different blocks. Combining lithological, structural and geochronological considerations, we interpret the North and South Liaohe Groups as having developed on a single late Archean basement that underwent Paleoproterozoic rifting associated with the intrusion of the Liaoji granitoids and the formation of the Liaohe Group, and closed upon itself in the Paleoproterozoic.

Acknowledgement

Trace element and Hf-Nd isotopic profiling of crustal contamination across the marginal zone of the Muskox intrusion, Nunavut

ROB A. MACKIE[1] JAMES S. SCOATES[1], DOMINIQUE WEIS[1], CLAUDE MAERSCHALK[2] AND DAVE PECK[3]

[1]Earth & Ocean Sciences, University of British Columbia, Vancouver, BC, Canada (rmackie@eos.ubc.ca)
[2]DSTE, Université Libre de Bruxelles, Brussels, Belgium
[3]Anglo American Exploration (Canada) Ltd, Vancouver, BC, Canada

We present the first combined trace element, Hf-Nd isotopic study from the marginal zone of the 1.27 Ga Muskox intrusion in order to constrain the extent and character of crustal contamination and the potential for formation of Ni-Cu-PGE sulphide mineralization. The two regions studied, West Pyrrhotite Lake (WPL) and Far West Margin (FWM), have different characteristic chemical and isotopic variations. The WPL region is adjacent to metaplutonic rocks, is unmineralized, and records the complete stratigraphy of the marginal zone. The FWM region however is adjacent to metasedimentary rocks, is weakly mineralized, and the contact norite is not present. Trace element and isotopic data record a sharp increase in crustal contamination within 5 m of the contact in both regions, however elevated La/Sm and La/Nb values do extend up to 60 m from the contact at the FWM. Initial ε_{Nd} and ε_{Hf} (1.27 Ga) values within the marginal zone range from 0 to -12 and +2.1 to -15, respectively, and T_{CHUR} model ages range from 1.13 Ga in peridotite to 2.5 Ga in contaminated gabbronorite. The adjacent country rocks have much higher ε_{Hf} and ε_{Nd} values at 1.27 Ga ranging from -20 to -29 and -14 to -16. The initial ε_{Nd} values of peridotite within the marginal zone overlap those from the overlying 1500-m-thick layered series [1] confirming an undepleted mantle source. The combined Hf-Nd isotopic and trace element results indicate that significant crustal contamination is restricted to a thin boundary zone especially in the WPL region. As a result, the conditions for formation of significant sulphide mineralization in the marginal zone of the Muskox intrusion are not optimal. The volume of contaminated magma was insufficient to generate a large quantity of sulphide liquid and the metal content of sulphide was limited by the inability of this sulphide liquid to interact with subsequent magma pulses.

Reference

[1] Stewart, B.W. & DePaolo, D.J. (1996) AGU Geophysical Monograph **95**, 277-292.

Os-Ir-Ru alloys and Ru-Os sulfides from clinopyroxenite-dunite complexes: A combined EMPA, LA MC-ICP-MS and N-TIMS study

K.N. MALICH

NATI Research JSC, P.O.Box 112, St.Petersburg M-135, 196135, Russia (knm_2004a@yahoo.com)

The Kondyor, Inagli, Bor-Uryah and Guli clinopyroxenite-dunite complexes, located in the limits of the Siberian Craton, are associated with platinum-group elements (PGE) placer deposits. The compositionally diverse platinum-group minerals (PGM) from these placer deposits have been studied by a number of modern techniques including SEM, EMPA, LA MC-ICP-MS and N-TIMS.

Detrital Pt-Fe alloy grains constitute the majority of PGM at Kondyor and Inagli, whereas Os-rich alloys [i.e., osmium Os, iridian osmium (Os,Ir)], osmian iridium (Ir,Os) and Ru-Os sulfides are subordinate species. In contrast, Os-rich alloy grains predominate at Guli, whereas the detrital PGM assemblage at Bor-Uryah contains equal amounts of Pt-Fe and Os-Ir alloy grains.

Since the concentration of Re in all PGM grains is less than 0.05 wt.%, the isotopic effect resulting from the radioactive decay of ^{187}Re can be considered negligible. Consequently, the value of ^{187}Os/^{188}Os in the detrital PGM corresponds to that in the source area at the time of PGM formation. The ^{187}Os/^{188}Os value measured by LA MC-ICP-MS and N-TIMS in osmium (80-100 wt. % Os) varies from 0.12326 ± 0.00001 to 0.12529 ± 0.00001. The ^{187}Os/^{188}Os value in PGMs with Os contents between 50 and 79 wt.% (i.e., PGE alloys of the system Os-Ir-Ru and Os-Ru-Ir-Pt) ranges from 0.12309 ± 0.00002 to 0.12775 ± 0.00001. The ^{187}Os/^{188}Os values in PGM, which contain Os in the range 1-31 wt. % (i.e., laurite, rutheniridosmine and erlichmanite) show a less pronounced variation, from 0.12333 ± 0.00015 to 0.12462 ± 0.00009.

In contrast to PGM from ophiolites, the main set of PGM in this study (n=96) closely matches the present-day ^{187}Os/^{188}Os values for depleted mid-ocean ridge mantle (DMM; 0.1246 ± 0.0014, [1]).

References

[1] Snow J.E. and Reisberg L. (1995) *Earth. Planet. Sci. Lett.* 136, 723-733.

He, Ar, S, O and H isotopic data and their implications for the gnesis of the Daduhe gold deposits along the eastern margin of the Tibetan Plateau, northwest china

JINGWEN MAO AND XIAOFENG LI

Institute of Mineral Resources, Chinese Academy of Geological Science, Beijing 100037

The Daduhe gold district is located in the eastern part of the Indo-Eurasian collision belt eastern margin of the Tibetan Plateau. The region is characterized by large faults and strike-slip systems related to escape tectonics during the Indo-Eurasia collision. A lot of gold deposits and occurrences were developed along both Jinshajiang-Ailaoshan strike-slip fault and the western margin of the Yangtze Craton, the latter is mainly includes the Daduhe, Shimian and Jinpingshan gold districts.

The Daduhe gold district comprises several shear-zone-controlled Tertiary lode gold deposits. The deposits are hosted in a Precambrian granite-greenstone terrane within the Yangtze Craton. The gold mineralization occurs mainly as auriferous quartz veins with minor sulfide minerals. Fluid inclusions in pyrite have ^{3}He/^{4}He ratios of 0.16 to 0.86 Ra, whereas their ^{40}Ar/^{36}Ar ratios range from 298 to 3288. The He and Ar isotope data indicate mixing of fluids of mantle and crustal source. The δ^{34}S values of pyrite are 2.5 ± 1.0 ‰ (n=12), suggesting it either introduced directly from the mantle or by leaching from mafic country rocks. Hydrothermal quartz has δ^{18}O values (with estimated temperature ranging from 220 to 250ºC) between 7.9 and 14.7 ‰ and δD values between -39 and -108 ‰, indicating mixing of magmatic and meteoric fluids. The noble gas isotopic data, along with the stable isotopic data suggest that the ore-forming fluids have a dominantly crustal source with a significant mantle component. The volatiles in the ore-forming fluids are associated with the degassing of mantle along deep faults during the covergent tectonic environment.

Acknowledgement

Origin of Yunnan potassic rocks: Re-Os isotope evidence

Q. MENG[1], E. WIDOM[1], X. MO[2], X. YU[2] AND Z. ZHAO[2]

[1]Department of Geology, Miami University, 114 Shideler Hall, Oxford, OH 45056, USA (mengq@muohio.edu, widome@muohio.edu)
[2]China University of Geosciences, Beijing 100083, P.R China (moxx@cugb.edu.cn, xhyu@cugb.edu.cn, zdzhao@cugb.edu.cn)

Post-collision, potassic magmatism is a common feature in many collisional orogens around the world. Western Yunnan potassic magmas (ca. 40 to 30 Ma) are believed to have formed in response to convective thinning of the lithosphere. Major, trace, and Sr, Nd, and Pb isotope data in Yunnan potassic lavas have been interpreted to reflect derivation from a phlogopite-bearing lithosphere mantle source region that has been modified by subduction-related processes [1, 2].

We report here preliminary Re-Os isotopic results of potassic rocks collected from the Jianchuan and Erhai area and both sides of the northern Ailao Shan – Red River fault, west Yunnan. Total Os concentrations range from 0.004 to 1.4 ppb, and Re concentrations range from 0.01 to 0.769 ppb, with $^{187}Re/^{188}Os$ ratios varying from 0.59 to 283. Age-corrected $^{187}Os/^{188}Os$ ratios range from 0.13339 to 0.77661. In accord with major and trace element and Os isotopic characteristics, these samples are divided into three groups. Group A has very high MgO (21%) and $^{187}Os/^{188}Os_i$ (0.17317) higher than depleted SLCM, OIB or MORB sources, and may be derived by high degree melting of a strongly metasomatized lithospheric mantle source. Group B has lower MgO (5-8%) and lower $^{187}Os/^{188}Os_i$ ratios (0.133 to 0.140) but high Os concentrations (0.8-1.4 ppb), and may be derived from lower degrees of melting of a less strongly metasomatized lithospheric mantle source. These samples have Os isotope signatures within the range of potassic rocks from Brazil, southeastern Spain, the Tibetan Plateau, the Colorado Plateau and southwestern Arkansas, which also have been attributed to lithospheric mantle sources. Group C has much lower Os concentrations (0.004-0.036 ppb) and high $^{187}Os/^{188}Os_i$ and $^{187}Re/^{188}Os$ ratios (0.459-0.777 and 112-283, respectively), interpreted either as crustal melts or magmas contaminated by crustal assimilation.

References

[1] Chung S. L. et al. (2001) *Geology* **25**, 311-314.
[2] Xu Y. G. et al. (2001) *Geology* **29**, 863-866.

Compound specific D/H isotopic composition of Orgueil and Murchison Insoluble Organic Matter

L. REMUSAT[1,2], F. PALHOL[3], F. ROBERT[1], S. DERENNE[2] AND C. FRANCE-LANORD[3]

[1]LEME, MNHN Paris, France (robert@mnhn.fr)
[2]LCBOP, ENSCP Paris, France (laurent-remusat@enscp.fr)
[3]CRPG, CNRS Nancy, France (fpalhol@crpg.cnrs-nancy.fr)

Insoluble Organic Matter (IOM) constitutes the major part of organic matter in carbonaceous chondrites. Bulk isotope composition of D, C and N, determined by stepwise pyrolysis revealed large enrichments interpreted as the signature of an interstellar origin but also pointed to a lack of homogeneity in the isotope composition of the IOM. It is thus especially important to determine the isotope composition at the molecular level. However, unlike soluble compounds, only few data are published on compound specific isotope ratios of IOM building blocks. This is likely because the latter have first to be recovered from IOM thanks to degradation. Indeed, IOM consists of highly substituted small aromatic units cross-linked by branched aliphatic chains. Recently, a ^{13}C GCirMS study on pyrolysis products of Orgueil and Murchison IOM, i.e. on the aromatic moieties, led to values consistent with bulk data and showed that ^{13}C isotope composition of the IOM is not homogeneous at the molecular level. However, no similar study was carried out so far on the hydrogen isotope composition of the IOM and the aforementioned work only dealt with the aromatic moieties.

We here report a Deuterium GCirMS study on both the aliphatic linkages and the aromatic units of Orgueil and Murchison IOM. The aromatic units have been extensively characterized by pyrolysis-GC-MS but no precise information was available on the aliphatic linkages. To this end, the latter were released through ruthenium tetroxide oxidation, which is able to oxidize the aromatic units without degrading the aliphatic substituents.

We thus obtained the first molecular information on the aliphatic linkages in chondritic IOM. Their chain length is short (up to 7 carbon atoms), branched and comprises ether or ester functions. The high level of cross-linking was demonstrated by the occurrence of chains linking three aromatic units. The D isotope composition of the oxidation products confirmed a strong enrichment in Deuterium and showed some heterogeneity in the values. In a parallel study, pyrolysis products are being analysed in a same way. Comparison of the values should provide a clue on the relationship between aliphatics and aromatics in chondritic IOM.

Stable isotopic composition of pedogenic carbonates in Chinese loess sequences: Information for paleo-summer monsoon strength

X.F. Sheng[1], J. Chen[2], J.D. Yang[2], Y. Chen[2]
AND J.F. Ji[2]

[1]Institute of isotope hydrology, Research Academy of Hohai University, Nanjing 210098, China (shenxuer@263.net)
[2]Departmen of Earth Sciences, Nanjing University, Nanjing 210093, China

As an important paleoclimatic archive, the loess-paleosol sequence on the Chinese Loess Plateau has been widely studied during the past decades, which serves as a complete record of East Asian monsoon evolution and embodies the regional response to global changes. The bulk samples from the Luochuan, Xifeng and Huanxian loess sections over the last 130ka were separated into three grain size fractions, i.e. >45μm, 45~2μm and <2μm. It is shown that $\delta^{13}C$ and $\delta^{18}O$ of carbonates in different fractions differ greatly. There is a striking contrast between micrographs of the carbonates in the >45μm fraction and that of in the <2μm fraction. Compared with $\delta^{13}C$ and $\delta^{18}O$ of authigenic carbonate in fossil snail shells and rhizoconcretion, it can be concluded that the carbonate in the >45μm fraction are mainly detrital, while the carbonate in the <2μm fraction is mainly pedogenic, precipitated during pedogensis.

$\delta^{13}C$ and $\delta^{18}O$ of pedogenic carbonate (the <2μm fraction) in the Huanxian, Xifeng and Luochuan sections reflect a spatial evolution of paleo-summer monsoon strength, i.e. decreasing from southeast to northwest. The fact that the C_4 plant contents calculated from $\delta^{13}C$ at the three regions has increased since the last 130ka denotes that the precipitation in these areas decreases gradually. According to paleo-temperatures and the C_4 contents calculated from $\delta^{13}C$ and $\delta^{18}O$ in the pedogenic carbonate and rhizoconcretion, the long-term variation of paleoclimate and paleoenvironment in Luochuan area over the last 2.5 Ma can be divided into two stages around the paleosol layer S_5. Before S_5 formation, the summer monsoon strength generally increased with alternating rise and decline of winter monsoon intensity, and the temperature and precipitation increased gradually. After S_5 formation, intensified winter monsoon causes the decreases of the temperature and precipitation and increase of C_4 plant contents.

Acknowledgement

Correction strategies in deuterium analysis using chromium reduction

R. van Geldern[1] AND A. Suckow[1,2]

[1]Leibniz Institute for Applied Geosciences (GGA), Stilleweg 2, 30655 Hannover, Germany (r.geldern@gga-hannover.de)
[2]Isotope Hydrology Laboratory, IAEA, Wagramer Strasse 5, A-1400 Vienna, Austria (axel.suckow@iaea.org)

Introduction

High precision deuterium isotope analysis (D/H) of water is routinely carried out by using a hot chromium reactor. One crucial point is to observe and correct for the machine drift. Consequently, different strategies for drift correction were proposed (e.g. Nelson and Dettman, 2001; Werner and Brand, 2001). In this study different correction approaches were tested for their influence on quality control and their usability in day to day analysis. Measurements were carried out on a H/Device coupled to a Delta S mass spectrometer.

Results and Discussion

Different reactor types (standard packing and alternative mix proposed by Nelson and Dettman, 2001 for longer reactor life) were tested for differences in drift behavior. Provided that all other parameters are identical, the results show a strict linear drift for the standard packing and a polynomial drift for the alternative packing of the reactor.

Miscellaneous correction functions, including polynomial, linear point-to-point and Rayleigh fractionation were evaluated. Results show that a simple second order polynomial regression to the drift of the signal from the standard bellow yields the best results. Two quality control standards treated as unknowns were measured in each run. After this correction external reproducibility - defined as standard deviation of the control standards during all runs - was 0.5 ‰ and 0.7 ‰, respectively.

Reactors with different packing were reheated several times and the results of different runs were compared. It turned out that reheating of reactors has no influence on the quality of the data, a fact that is generally worried about. The influence of an additional memory correction applied to the raw data prior to drift correction was evaluated, too.

Conclusions

The results show that an external precision of 0.5 ‰ is reachable in routine analysis if this standardized polynomial drift correction is applied.

References

Nelson, S.T. and Dettman D. (2001), Rapid. Comm. Mass Spec. **15**, 2301-2306.
Werner, R.A. and Brand, W.A. (2001), Rapid. Comm. Mass Spec. **15**, 501-519

Stable Cr isotope ratio measurements using a double-spike method and high-resolution MC-ICP-MS

F. VON BLANCKENBURG AND R. SCHOENBERG

Institut für Mineralogie, Universität Hannover, Germany
(r.schoenberg@mineralogie.uni-hannover.de)

Reduction of Cr(VI) to Cr(III) in aqueous solutions is accompanied by a significant mass-dependent Cr isotope fractionation of more than -3‰ per atomic mass unit (Ellis et al., 2002). This makes stable Cr isotopes a sensitive tracer to detect and quantify redox changes in a variety of geochemical reservoirs.

We determine stable Cr isotope ratios on a ThermoFinnigan Neptune multicollector ICP-MS at high mass resolution mode. A ^{50}Cr-^{54}Cr double spike of well-known isotope composition is added to and homogenised with the sample chromium prior to chemical purification. The double-spike addition allows for accurate in-run determination of the instrumental mass bias, but also accounts for possible mass-dependent fractionation of Cr isotopes during chemical processing of the sample. Purification of chromium from the sample matrix is performed by a combination of anion and cation exchange chromatography adapted from the protocol of Ball and Bassett (2003). $\delta^{53}Cr/^{52}Cr$ values of Cr standards that were passed through the ion exchange chromatography (n=2) are equal to those that were not subject to chemical purification (n=15). The overall reproducibility of the Cr standards was ± 0.05 ‰ (2 S.D.), however, the long-term reproducibility of the method remains to be assessed in more detail. An unspiked Cr(VI) standard was loaded onto the anion column followed by sequential release from the resin via reduction. Prior to isotope analyses, adequate portions of the double-spike were added to the eluted aliquots. Sequential release from the anion resin via reduction was accompanied by Cr isotope fractionation from −2.76‰ in the first to +5.19‰ in the last aliquot. Overall Cr recovery during chemical purification was determined to be 75-85%. Thus, the above-mentioned results demonstrate that the double-spike method is required to account for Cr isotope fractionation introduced during chemical purification. Chromites from both the Bushveld and Great Dyke layered intrusion do not show any variation in their Cr isotope composition with stratigraphic height and are indistinguishable from each other.

References

Ellis, A.S. et al., (2002), Science, 295, 2060-2062.
Ball, J.W. and Bassett, R.L., (2000), Chem. Geol. 168, 123 ff.

The Determination of atomic weights by new analytical techniques

M.E.WIESER

Department of Physics and Astronomy, University of Calgary, Canada (mwieser@ucalgary.ca)

New analytical techniques, including single and multiple collector inductively coupled plasma-mass spectrometry (ICP-MS) and Secondary Ion Mass Spectrometry (SIMS), have recently provided atomic weights of chemical elements with unparalleled precision. For many elements (including, but not limited to, B, Si, Ca, Mo, Zn, and Cd) the comparison of results obtained by different laboratories using different analytical techniques is hampered by the lack of suitable reference materials of known (or at the very least agreed-upon) isotope composition. For example, ICP-MS analyses on boron reference materials distributed by the International Atomic Energy Agency have very low uncertainties in their atomic weights, but the values do not agree well with previous thermal ionization mass spectrometric (TIMS) measurements using both positive and negative ions. In fact, ICP-MS values from different laboratories do not overlap within 2s uncertainties. The reasons for the lack of agreement are not well understood. One of the main tasks of the International Union of Pure and Applied Chemistry (IUPAC) Commission of Isotope Abundances and Atomic Weights (CIAAW) is to evaluate newly published isotope abundance data to establish current best values of atomic weights that are both precise and accurate relative to a partionable, highly homogeneous, and widely recognized reference material for each element. This presentation will highlight the challenges of making reliable isotope abundance measurements and the work that CIAAW is doing to ensure that atomic weight data are both precise and accurate.

Pb isotopic variability in leached and non-leached magnetic fractions of plagioclase from the Laramie anorthosite complex, Wyoming

GWEN WILLIAMS, JAMES S. SCOATES
AND DOMINIQUE WEIS

EOS, University of BC, 6339 Stores Rd, Vancouver, BC
V6T1Z4 Canada (gwilliams@eos.ubc.ca)

The trace element (HR-ICP-MS) and Pb isotopic compositions (MC-ICP-MS) of leached and non-leached feldspar fractions and whole rocks from four different rocks (anorthosite, leucogabbro, troctolite, monzosyenite) from the 1.43 Ga Laramie anorthosite complex (Wyoming) were determined. Significant trace element differences occur between different magnetic plagioclase fractions from the leucogabbro and troctolite. The more magnetic fractions have lower concentrations of trace elements, higher abundances of inclusions and Fe-Ti oxide lamellae, and represent the cores of plagioclase crystals. The least magnetic fractions, which contain higher concentrations of trace elements, lack inclusions and Fe-Ti oxide lamellae, are from the rims. The non-leached plagioclase fractions have Pb isotopic ratios ($^{206}Pb/^{204}Pb$ = 16.840-18.177, 17.090-17.768, and 16.971-17.291) that span a greater range of values than the Pb isotopic values of their corresponding whole rocks ($^{206}Pb/^{204}Pb$ = 17.255-17.666). The isotopic variation amongst the non-leached fractions is a result of higher U concentrations in the rims of the crystals producing higher radiogenic Pb contents through closed system radioactive decay during the 1.43 billion years since crystallization. In contrast, Pb isotopic ratios of leached plagioclase fractions from individual samples ($^{206}Pb/^{204}Pb$ = 16.665-16.713, 16.831-16.864, and 16.794-16.824) are almost within error and significantly different from the widely varying Pb isotopic ratios of the non-leached fractions. These results have important implications for studies where the Pb isotopic compositions of plagioclase are determined *in situ* by laser ablation MC-ICP-MS or SIMS. They also underscore the importance of leaching plagioclase before using the Pb isotopic composition of plagioclase as a proxy for the Pb isotopic composition of the magma from which the plagioclase crystallized.

Zircon Hf isotope evidence for the existence of Early Archean crust in the Yangtze craton of China

S.-B. ZHANG, Y.-F. ZHENG AND Y.-B. WU

School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China (sbzhang@mail.ustc.edu.cn)

The presence or absence of Early Archean crust in different continents provides an important basis for a comparison of their growth histories. Zircons Hf isotopes are a powerful tool for this purpose because the zircon Lu-Hf isotope system is much more resistant to hydrothermal alteration or metamorphism than other isotope systems such as Rb-Sr, U-Pb and Sm-Nd. Since the finding of ca. 3.8 Ga detrital zircon in the North China craton by means of SHRIMP U-Pb dating (Liu et al., 1992), it has been intriguing whether the Yangtze craton, one of the two major blocks constituting the basement of China continent, also contain the crustal reflict of Early Archean. It is generally accepted that the basement of the Yangtze craton mainly formed in the Paleoproterozoic, only with minor Archean rocks of ≤3.3 Ga (Chen and Jahn, 1998; Qiu et al., 2000). A combined study of zircon U-Pb dating and Hf isotope analyses for the Kongling migmatite from this craton reveals the existence of >3.5Ga rocks. An age of 2916±31 Ma is directly acquired by SHRIMP U-Pb dating. Calculated $\varepsilon_{Hf}(t)$ values show a bimodal distribution of −7.1±0.6 and −3.5±0.6, corresponding to a bimodal distribution of two-stage Hf model ages at 3.75±0.04 Ga and 3.52±0.03 Ga, respectively. These imply that their source materials can be divided into two groups, which were episodically extracted from the depleted mantle at about 3.5 Ga and 3.7 Ga, respectively, and remelted at about 2.9 Ga. This provides the first evidence for the existence of Early Archean (>3.5Ga) rocks in the Yangtze craton. Thus the early evolution history of the Yangtze craton may resemble the North China craton that has the crustal reflict as old as 3.8 Ga. These Early Archean rocks resided in the crust of the Yangtze craton for at least several hundreds of million of years before remelting, probably leaving some clues to be traced and verified.

References

Chen J.F. and Jahn B.-m., (1998), *Tectonophysics*, **284**, 101-133.
Liu D.Y., Nutman A.P., Compston W., Wu J.S., Shen Q.H., (1992), *Geology*, **20**, 339-342.
Qiu Y.M., Gao S., McNaughton N.J., Groves D.I., Ling W.L., (2000), *Geology*, **28**, 11-14.

C, H, and O isotope characteristics of the Shuangwang gold deposit, West China

ZUOHENG ZHANG[1], JINGWEN MAO[1], XIAOFENG LI[1], RUITING WANG[2] AND ZHILIANG WANG[1]

[1]Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China
[2]Bureau of Exploration for Nonferrous Metals in Northwest China, Xi'an 710054, China

The Shuangwang gold deposit in the western Qinling orogenic belt, central China, is localized between the Shangdan and Lixian-Shanyang regional faults and 1-5km far from the Xiba intrusion. Two mineralization stages can be recognized in the Shuangwang gold deposit in the light of different assemblage of minerals and their cut through relations, i.e. albite-ankerite-pyrite stage (stage I), and the pyrite-quartz-calcite vein stage (stage II).

The $\delta^{13}C$ values of the ankerite mainly range from -5.6 to -7.8 per mil and are close to the estimated value (-7‰) of the mantle material defined by Faure (1986). The $\delta^{13}C$ values of calcite are of -1.8 – -4.9 per mil, which are lower than those of marine carbonate (0.5‰±1.56‰), and higher than those of mantle carbonate (-5.1‰±1.4‰). Both of the two group values also approximate or partly overlap the range -4.7‰±1.2‰ of kimberlitic, and -6‰±2‰ of initial mantle reservoir. These results may suggest that the carbon in the ores of the Shuangwang deposit was mainly mantle-derived.

The δD values vary from -60 to -76 per mil for ankerite of stage I, and from -60 to -74 per mil for calcite and from -65 to –70 per mil for quartz of sage II, respectively. The corresponding calculated $\delta^{18}O_{fluid}$ values vary from +7.3 to +11.8 per mil, -1.0 to 1.5 per mil, and from +1.4 to +9.0 per mil, respectively. The scope of ankerite almost overlaps the range of +5.5 – +9.5 per mil for magmatic water suggested by Ohmoto (1986) and Sheppard (1986), with a slight shift to metamorphic water. As to that of the quartz, most of values are exactly plotted into the range of +5.5 – +9.5 per mil. That of calcite displays a characteristic of meteoric water. The magmatic water comprised the dominantly ore-forming fluids with some metamorphic water mixed into the ore-forming process during the main mineralization stage, and some amount of meteoric water were involved in the later ore-forming system in the Shuangwang gold deposit.

References

Faure G. 1986. Principles of isotope geology, 2nd edition. New York: Wiley & Sons, 497-507
Ohmoto H. 1986. Stable isotope geochemistry of ore deposits. Reviews in Mineralogy, 16: 491-559
Sheppard S M F. 1986. Characterization and isotopic variations in natural waters. Reviews in Mineralogy, vol. 16: 165- 183

Isotopic constraints on the timing and source characteristics of Late Mesozoic mafic volcanism in the Da Hinggan Mountians, NE China

XINHUA ZHOU, JIFENG YIN, FEI WANG, LIANGCHANG ZHANG AND YUTAO ZHANG

Institute of Geology & Geophysics, Chinese Academy of Sciences, Beijing, 100029, China
(xhzhou@mail.igcas.ac.cn)

Late Mesozoic calc-alkaline volcanic rocks are extensively spread and constitutes major part of Da Hinggan Mountains (DHAM), which is situated adjacent to the border of NE China, Mongolia and Russia. The volcanism is dominated by high-K calc-alkaline series, It has been proposed that DHAM could be the magmatic response either to the subduction of paleo-Pacific Plate or to the closure of the paleo-Asia and/or Mongolia-Okhotsk Oceans.

To clarify the timing of volcanism and the role of underlain lithosphere in magma genesis, a systematic geochronological and geochemical study has been taken, The results show that he peak volcanism is within a period of Early Cretaceous, not scattered in Late Jurassic to Early Cretaceous, as commonly believed before. The Sr-Nd-Pb isotope surveying indicates that (1) A distinctive and contrasting pattern of isotope signatures across the southern boundary has been observed. A remarked EM 1 signature feature the isotope system of basaltic rocks on the side of the North China Craton, whereas the primitive to slightly depleted signature dominates that of basaltic rocks on the side of southern DHAM, (2) No pattern difference of isotope signatures between northern and southern sections of DHAM, which is divided by a Paleozoic suture zone in between. Both show the primitive to slightly depleted signature in Nd isotopes and slightly enriched feature in Sr isotopes, which are concordant with its arc signature as evidenced by the spider diagram. This study presents a positive argument showing that the magma sources of volcanic rocks have been highly influenced by the underlain lithosphere. It strongly suggests that the juvenile isotopic signature of most of the DHAM magma source is consistent with the hypothesis of reactivation of Paleozoic subducted zone (Zhou et al., 2001). It also provides further geochemical support to the significant growth of continental crust in Phanerazoic in central-eastern Asia (Jahn et al., 2002).