

## Environmental degradation and health risks in Pearl River Delta, China

J. QI

South China Normal University, Guangzhou 510631, PR China (jungzh@163.com)

With the rapid process of industrialization and urbanization, cities have multiplied and expanded rapidly over the past 2 decades. Cities are sources of creativity, technology, and engines for economic growth. However, they are also sources of health hazards from the changed society, degraded environment and regional climate change.

The Pearl River Delta, including 9 cities (Guangzhou, Shenzhen, Foshan, Zhuhai, Dongguan, Zhongshan, Huizhou, Jiangmen, Zhaoqing), covers an area of 24437 km<sup>2</sup> and a large population of 42.8 millions. The unprecedented environmental degradation in the region, accompanied by complex interaction between urbanization and global environmental change, which places human health at risk on a large spatial and temporal scale. A range of urban health hazards and associated health risks in the Pearl River Delta result from a variety of factors including heat islands, air pollution, water crisis, soil pollution, infectious diseases, and urban consumerism; in addition, some hazardous health conditions are associated with inequality in living and working conditions. For sustainable development on environment and human health in the Pearl River Delta, it is urgent to understand the possibilities of health problems resulting from environmental changes related with urbanization. The author suggest 3 main areas for policy action and research direction: (1) the need to get full-scale information related to environmental monitoring data and health data, (2) the need to discuss the relationship among economic development, natural resources, environmental pollution and human health, (3) the need to provide new methodological approaches and techniques to implement interventions for sustainable development in the Pearl River Delta.

## <sup>40</sup>Ar/<sup>39</sup>Ar geochronology of phengite from blueschist facies rock of the Myanmar and its implication

MIN QI<sup>1</sup>, ZEMING ZHANG<sup>1</sup>, HUA XIANG<sup>1</sup>, ZENGQIU ZHONG<sup>2</sup> AND HUANING QIU<sup>3</sup>

<sup>1</sup>Institute of Geology, Chinese Academy of Geological Sciences, No. 26 Baiwangzhuang Road, Beijing 100037, China, minqiqi@gmail.com

<sup>2</sup>China university of Geosciences, No. 388 Lumo Road, Wuhan, 430074, China

<sup>3</sup>Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, No. 511 TianHe Area, Guangzhou, 510640, China

High-pressure (HP) low-temperature (LT) metamorphic rocks (blueschist and eclogite) in orogenic belts provide valuable information related to subduction processes of oceanic lithosphere. The blueschist together with garnet amphibolite, marble, quartzite are the associated rocks of the Myanmar jadeitite occurred in ultramafic rocks of the east ophiolite belt along the eastern margin of the Indian plate. The blueschist is composed mainly of glaucophane, phengite, albite, quartz, epidote with minor of actinolite and sphene. Among them glaucophane occurs as large grains whereas actinolite is fine hair-like in the matrix. The amphiboles in blueschist show variable compositions. Phengites in blueschists are characterized by a high Si content of 3.35–3.37 pfu, Mg content of ca. 0.27 pfu, Fe content of ca. 0.17pfu. The <sup>40</sup>Ar/<sup>39</sup>Ar dating performed on phengite from the blueschist obtained an age of 147.0 ± 1.5 Ma, representing the metamorphic event during the subduction of oceanic crust. This age is older than <sup>40</sup>Ar/<sup>39</sup>Ar ages of 123.9 ± 3.4 Ma of jadeite and 134.8 ± 1.4 Ma of sodic amphibole from the Myanmar jadeitite, and also older than the 100–80 Ma ages of high-pressure metamorphism of the blueschist derived from the subduction of the Neo-Tethys in the Western Himalayan orogen. To our knowledge, the 147 Ma age is probably the earliest time for the initial subduction of the Neo-Tethys beneath the Eurasian continent.

## Cr isotopic evidence of enzymatic reduction of Cr(VI) catalyzed by a sulfate-reducing bacterium

LIPING QIN<sup>1,2</sup>, RUYANG HAN<sup>2</sup>, ROMY CHAKRABORTY<sup>2</sup>, JOHN N. CHRISTENSEN<sup>2</sup> AND HARRY R. BELLER<sup>2</sup>

<sup>1</sup>Key Laboratory of Crust-Mantle Materials and Environments, University of Science and Technology of China, Hefei, 230026, China (lpqin@ustc.edu.cn)

<sup>2</sup>Lawrence Berkeley National Laboratory, 1 Cyclotron Rd., Berkeley, CA 94720, USA

Several studies have suggested that Cr isotopic signature could be used for distinguishing between different Cr(VI) reduction pathways [1,2]. We previously showed distinct Cr isotopic fractionation behavior under aerobic versus denitrifying conditions with a single bacterial species, *Pseudomonas stutzeri* strain RCH2, even though the Cr(VI) reduction rates were comparable under those two conditions [3].

To further evaluate Cr fractionation mechanisms associated with enzymatic Cr reduction, in the current study, we used the sulfate-reducing bacterium *Desulfovibrio vulgaris* strain RCH1 isolated from DOE's Hanford 100H site. We found significant Cr(VI) reduction with lactate as the electron donor either in the presence or absence of sulfate; thus, the Cr isotopic signature was examined with and without sulfate. Under both conditions, Cr isotopic fractionation followed the same Rayleigh fractionation with an  $\alpha$  value of 0.99806. This value is significantly smaller than the abiotic fractionation factors observed previously and is also smaller than the values from experiments with *Shewanella oneidensis* MR-1 using much lower electron donor concentrations [2], but is very similar to values from experiments with higher electron donor concentrations with either *P. stutzeri* RCH2 under aerobic conditions [3] or *S. oneidensis* MR-1 [1]. Since abiotic reduction of Cr(VI) by sulfide and Fe(II) could also have been involved in these experiments, abiotic reduction experiments with these reagents were conducted. The  $\alpha$  values in these experiments were very different from 0.99806, implying that enzymatic reduction was dominant under the conditions tested with strain RCH1.

[1] Ellis *et al.* (2002) *Science* **295**, 260-262. [2] Sikora *et al.* (2008), *Geochim. Cosmochim. Acta* **72**, 3631-3641. [3] Han *et al.* (2012) *Appl. Environ. Microbiol.* **78**, 2462-2464.

## Petrology and geochemistry of the Mesozoic potassic and sodic volcanic rocks in the Yishu deep fault zone, Shandong Province, eastern China: Petrogenesis and inferences on the evolution of the mantle sources

JIAN-SHENG QIU\*, LIANG LIU AND YOU-LIAN LI

State Key Lab for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing 210093, China (\*correspondence: jsqiu@nju.edu.cn)

Late Mesozoic potassic volcanic rocks are widespread along the Yishu deep fault zone and its both sides, but some sodic volcanic rocks are also developed in several parts of this region, especially in the interior of the fault. These rocks provide important constraints on the nature and evolution of the Late Mesozoic lithospheric mantle beneath the region. LA-ICP-MS zircon U-Pb dating yields ages of 124.0~118.7 Ma for the potassic rocks, and of 106.4~96.5 Ma for the sodic ones. Both the potassic and the sodic volcanic rocks show similar trace element features of LILE and LREE enrichment and HFSE depletion. However, the sodic volcanic rocks have lower REE (especially LREE) contents, lower Rb/Sr and La/Nb ratios, and display somewhat Pb depletions in the spidergram profiles. All the rocks have enriched Sr and Nd isotopic compositions, but the sodic volcanic rocks have slightly lower  $I_{Sr}$  ratios and higher  $\epsilon_{Nd}(t)$  values with respect to the spatially coexisted potassic volcanic rocks, e. g., the  $I_{Sr}$  and  $\epsilon_{Nd}(t)$  values of the coexisted sodic and potassic rocks in Tangtou basin are 0.7097~0.7100, -10.0~-11.8 and 0.7100~0.7106, -15.5~-17.0, respectively. Zircon  $\epsilon_{Hf}(t)$  values of the sodic rocks are also higher than that of the potassic rocks (specially -4.2~-16.6 for the sodic rocks and -13.2~-24.3 for the potassic rocks). The elemental and isotopic systematics indicates that the potassic volcanic rocks were generated by melting of enriched lithospheric mantle which was most likely induced by hybridism of foundering lower crust of the North China Craton at mantle depths, but the magma source of the sodic volcanic rocks contain some proportions of depleted asthenosphere mantle components. Based on a synthesis of the geology and geochemistry, it is suggested that the continued extension thinned the lithosphere and induced the upwelling of asthenospheric melts which mixed with previously enriched lithospheric mantle. Decompression partial melting of the mixed mantle source produced the sodic volcanic rocks.

## Experimental study of the reaction kinetics between CO<sub>2</sub>-bearing solution and olivine

LIN QIU<sup>1\*</sup>, ZHENGRONG WANG<sup>1</sup>, SHUANG ZHANG<sup>1</sup>,  
SHUN-ICHIRO KARATO<sup>1</sup>, JAY J. AGUE<sup>1</sup>,  
MICHAEL ORISTAGLIO<sup>1</sup>, EDWARD BOLTON<sup>1</sup>  
AND DAVID BERCOVICI<sup>1</sup>

<sup>1</sup>Department of Geology and Geophysics, Yale University,  
New Haven, CT, USA

(\*correspondence: lin.qiu@yale.edu)

Olivine, as one of the main constituents in mafic/ultramafic rocks, has been suggested as a promising candidate for trapping anthropogenic CO<sub>2</sub> permanently as carbonates because of its high dissolution and carbonation rates. In this study, we employed an experimental approach to quantitatively evaluate the carbonation reaction kinetics as CO<sub>2</sub>-rich solution interacts with olivine (Fo<sub>90</sub>).

Gem-quality olivine grains and olivine powders (<30µm or 50µm) reacted with CO<sub>2</sub>-containing solutions (e.g., 0.25 to 3M NaHCO<sub>3</sub> solutions, fluid/rock mass ratio 5 to 10) in gold capsules placed in a hydrothermal autoclave over durations of 1-14 days at 200 °C and 150 bar. The carbonation fraction (CF, the percentage of carbonated olivine over original olivine) was determined by comparing the concentration of dissolved-inorganic-carbon (DIC) in the solution before and after carbonation reactions.

Our results show that the CF could increase by ~20 times using fine olivine powders (<30µm) relative to the larger grains (~0.18 g/each), and the CF has a positive linear correlation with the concentration of NaHCO<sub>3</sub>. The maximum CF in our study reaches ~45%, obtained using <30µm olivine powders and 3M NaHCO<sub>3</sub> solutions within one day of the reaction. Further increase of experimental time, however, will not improve the CF, but result in the precipitation of secondary minerals (including talc), and sometimes the decomposition of the carbonates (i.e., magnesite). However, this scenario could be prevented by using less amount of solutions (fluid/rock<sub>mass</sub> = 1); in which case, the carbonation reaction is much faster as SiO<sub>2</sub> precipitates as amorphous Si-layer without the formation of secondary minerals. The amorphous Si layers still have voids and channels for the fluid/rock interactions. These observations help constrain the kinetics of the olivine carbonation reactions.

## Triplite in Baxiannao W deposit, southern Jiangxi, and its geological significance

QIU LIWEN<sup>1</sup> AND LI GUANGLAI<sup>2</sup>

<sup>1</sup>State Key Laboratory for Mineral Deposits Research, Nanjing University, Nanjing 210093, China

<sup>2</sup>College of Earth Science, East China University of Technology, Fuzhou 344000, China

A pink mineral was newly found in the Baxiannao tungsten deposit, southern Jiangxi province, China. Analytical results from Laser Raman spectra shows that its Raman shift (425.34, 454.64, 601.12, 981.97, 1040.50, 1073.1 cm<sup>-1</sup>) is in good concordance with that of sample Triplite R050186 from the ruff data base (432.08, 453.29, 611.42, 981.69, 1043.40, 1072.33 cm<sup>-1</sup>). The d values of high peak of powder XRD analysis are 1.639, 1.759, 2.032, 2.110, 2.221, 2.517, 2.602, 2.690, 2.735, 2.864, 3.038, 3.278, 3.442, 3.660, 4.299, 5.668, respectively, which well fit the standard 25-1080 triplite. Chemical composition from electron-microprobe analysis is MnO 50.19%~50.96%, FeO\* 7.74% ~7.78%, MgO 2.75%~2.89%, CaO 1.75%~2.12%, P<sub>2</sub>O<sub>5</sub> 30.95%~31.51%, F 7.21%~7.94%, and H<sub>2</sub>O 0.45%~1.02%, and hence the calculated chemical formula is (Mn, Fe, Mg, Ca)<sub>2</sub>PO<sub>4</sub>(F, OH). All these data prove that the mineral is triplite, the manganese end-member of triplite-zwieselite series. It occurs in the wolframite-bearing quartz vein and associated with quartz and fluorite, which indicates that the ore-forming fluid was rich in phosphor and fluorine. The triplite contains a lot of fluid inclusions of two phases. Almost all the fluid inclusions are aqueous-rich and many of them are larger than 150µm. Raman spectra show that the liquid phase is water while the gas phase contains not only H<sub>2</sub>O, but also CH<sub>4</sub> and CO<sub>2</sub>. The discovery of triplite together with quartz and fluorite in the tungsten deposit suggests that the related granite is most likely attributed to the fluorine-rich category.

## Geology and geochemistry of the Fenghuangshan skarn Cu deposit at Tongling area, Anhui Province, East China

HONGYING QU<sup>1\*</sup>, RONGFU PEI<sup>1</sup>, HONGCAI FEI<sup>2</sup>,  
JINWEN LI<sup>1</sup>, YONGLEI WANG<sup>1</sup> AND HAOLIN WANG<sup>1</sup>

<sup>1</sup>MLR Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China (\*correspondence: hongyingqu@126.com)  
<sup>2</sup>ACTA Geological Sinica (English Edition), Beijing, 100037, China

The Fenghuangshan skarn Cu deposit at Tongling area, Anhui Province, is a component of the Middle-Lower Yangtze River metallogenic belt. The Xinwuli quartz monzodiorite and granodiorite related to mineralization at Fenghuangshan are intermediate-acidic intrusive rocks derived from alkline basalt of upper mantle and contaminated by crust materials during magma evolution. We carried out key study for this deposit. Geochemical features, ore-forming fluids and chronology have been studied to understand ore-forming mechanism. Carbon, hydrogen and oxygen isotopes indicate that ore-forming fluids in the deposit mainly are derived from the magma with input of minor amount of meteoric water at the late stage of the mineralization. Sulfur and lead isotopic analysis indicate that ore-forming materials are from the mantle source. Re-Os isotopic dating of molybdenite from the Fenghuangshan Cu deposit yielded an isochronal age of 141.1±1.4 Ma with the model ages ranging from 139.1±2.4 to 142.0±2.2 Ma, which is consistent to zircon SHRIMP U-Pb ages of the related quartz monzodiorite and granodiorite. Dating analysis yielded ages of 136.0±2.0 to 143.0±2.4 Ma for the quartz monzodiorite (a weighted average of 139.4±1.2 Ma) and ages from 136.7±2.0 to 145.3±2.4 Ma for granodiorite (a weighted average of 141.0±1.1 Ma). These studies discuss that the relationship between mineralization and intrusion, helping to understand other skarn Cu deposits which have similar ore-forming settings.

## Classification of gemstone tourmalines from Central Brazil by chemistry nomenclature

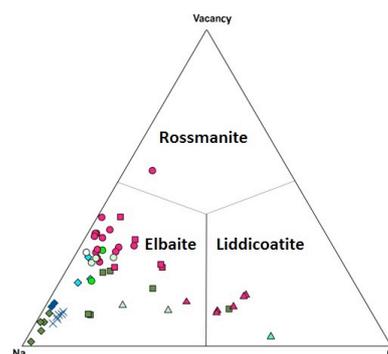
H.A. QUEIROZ<sup>1</sup> AND N.F. BOTELHO<sup>2</sup>

<sup>1</sup>University of Brasilia, Brazil  
(<sup>1</sup>hudsonq@gmail.com, <sup>2</sup>nilsonfb@unb.br)

Several handpicking mines were important gemstone sources, mainly tourmalines, during the 1970's and 80's in Tocantins State, Central Brazil.

The studied tourmalines exhibit a wide range of colours, black, dark and light blue, dark and light green, pink, purple and colourless, sometimes exhibiting zonation. Classification of tourmalines based on colour, for instance rubellite, indicolite, verdelite, was substituted by chemical nomenclature accordingly Henry *et al.* [1], based on crystal microprobe analysis and the cation distribution.

In colored crystals there are solid-solutions between four species, schorl, elbaite, liddicoatite and rossmanite. Dark-blue and dark-green crystals are examples of schorl-elbaite series; light green, pink and colourless are either elbaite-rossmanite or elbaite-liddicoatite series. Apparently, the calcic tourmaline liddicoatite occurs more frequently in pegmatites hosted in Ca-rich rocks, in a similar way of those from Anjanabonoina, Madagascar [2].



**Figure 1:** Colored tourmaline species by X site occupancy. The color of each data point is indicative of the color of tourmaline.

[1] Henry *et al.* (2011) *American Mineral.*, **96**, 895-913. [2] Dirlam *et al.* (2002) *Gems & Gemology*, **38**, 28-53.

## Levels and geochemistry of urban and rural atmospheric particulate matter in Spain

X. QUEROL, A. ALASTUEY, T. MORENO AND M. VIANA

Institute of Environmental Assessment and Water Research, IDAEA, CSIC, Barcelona, Spain

A review of PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub> geochemistry data collected in 1999-2011 from 40 air quality monitoring data, each with 1 to 10 years of data coverage, is presented with the aim of describing major features of urban, industrial and rural source contribution, as well as describing the major concentration trends and their causes.

Ambient air PM levels have markedly decreased in the last decade by around 35%. Although EC limit values are exceeded only in a few hotspots, urban PM levels still exceed by far the WHO guidelines. Causes accounting for these trends are discussed according to geochemical data.

Spatial gradients are very clear across Spain, especially levels of sulphate, nitrate, ammonia and mineral matter. Different emission patterns and climate features may account for these gradients. The incidence of African dust outbreaks on PM levels is also briefly described. Levels of carbonaceous aerosols are mostly influenced by vehicle exhaust emissions. Ranges of concentrations of levels of around 30 trace elements in the 40 sites are presented and discussed. The influence of major industrial hotspots is evidenced, but also the impact of vehicle wear emission in ambient levels of a number of relevant metals is evidenced. Results point to the very high impact of vehicle exhaust and road dust emissions on levels and composition of PM in urban areas. Biomass burning emissions may have local impact but not much at urban scale in the largest urban agglomerations in Spain. Finally, the relevance of specific industrial hotspots is also shown.

## Multi-Wavelength Raman survey of IOM from primitive meteorites

E. QUIRICO<sup>1\*</sup>, F-R ORTHOUS-DAUNAY<sup>1</sup>, P. BECK<sup>1</sup>, L. BONAL<sup>1</sup>, R. BRUNETTO<sup>2</sup>, E. DARTOIS<sup>2</sup>, T. PINO<sup>2</sup>, G. MONTAGNAC<sup>3</sup>, JN ROUZAUD<sup>4</sup>, C. ENGRAND<sup>5</sup> AND J. DUPRAT<sup>5</sup>

<sup>1</sup>IPAG UJF France (correspondence eric.quirico@obs.ujf-grenoble.fr)

<sup>2</sup>Institut d'Astrophysique Spatiale Orsay France

<sup>3</sup>Laboratoire de Géologie de Lyon, ENS/UCLB France

<sup>4</sup>Laboratoire de Géologie ENS-Paris France

<sup>5</sup>CSNSM IN2P3/Université Paris Sud Orsay France

We report a survey of the structure of Insoluble Organic Matter (IOM) of a series of 27 CR, CM, CI and ungrouped C2 carbonaceous chondrites by means of Infrared and Multi-Wavelength Raman micro-spectroscopy (244, 514 and 785 nm laser excitations). The IOM in some of these chondrites displays Raman and Infrared signatures that point to the past action of short duration thermal metamorphism, presumably triggered by impacts (e.g. PCA 91008, QUE 93005, Tagish Lake). Interestingly, IOM from other chondrites also display Raman characteristics consistent with a thermal processing. In this regard, IOM and Soluble Organic Matter (SOM) could be considered as two byproducts of organic precursors decomposed by thermo-degradation. The place where this process occurred, within parent body or protosolar disk prior accretion, cannot be firmly identified given the lack of precise knowledge on the nature of the organic precursors and of the time-temperature history of the parent asteroid. Our data also confirm that IOM is structurally more homogeneous in chondrites than in stratospheric IDPs and Antarctic Micrometeorites (AMMs). This suggests IOM contained in these particles was formed under more varying conditions. However, other mechanisms as ions irradiation or atmospheric heating/oxidation cannot be fully excluded for accounting for these variations.