

Geochemical characterization and origin of high saline pore fluids from the Chapopote asphalt volcano – Southern Gulf of Mexico

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High saline pore fluids in marine deep-sea sediments are well known, especially when evaporites exist in the underlying deep sub-surface. Nevertheless, the classification of brines is matter of debate over and over again. A major question in this context is, if the high content of total dissolved solids is generated by dissolution of evaporites or derived from evaporation residues.

During RV Meteor expedition M67/2 we have taken sediment and pore water samples from an isolated diapiric elevation within the Campeche Knolls area in the southern Gulf of Mexico. At this structure, named Chapopote, asphalt volcanism and hydrocarbon seepage has been documented. Here we present and discuss results from pore water analysis on sediments which have been recovered in the vicinity of the active vent sites. The most conspicuous feature is that interstitial waters from Chapopote knoll exhibit a strong, almost linear increase in salinity (from 37 g l⁻¹ to about 83 g l⁻¹). Modeling of transport and reaction processes give clear evidence that the pore water composition at these sites is controlled by diffusion only. Correspondingly, strong gradients observed for ratios of geochemically almost inert constituents, like Na:Cl, are solely explainable by differences in specific diffusion coefficients. Furthermore, these correlations let assume that the composition of surface pore waters at Chapopote knoll are not significantly influenced by the dissolution of salt minerals. Based on oxygen- and hydrogen-isotope data, which indicate to simple dilution effects, clay mineral dehydration processes seems to be negligible.

In combination with the application of geochemical equilibrium calculation, the similarity of the relative composition of the Chapopote brine to formation waters of Jurassic and Cretaceous age would seem to suggest a local upward percolation of the later. Accordingly, high saline waters at Chapopote would originate from a dilution of a Cretaceous or Jurassic residual brine, which would have to be expected 40-50 m bsf. Based on bromide concentrations its degree of evaporation can be approximated to 25-45 times.

Nature and reactivity of ferrous iron forms through a subsurface redox transition zone probed by contact with the pertechnetate anion

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Aquifer systems can display marked changes in redox properties over relatively short distances as a result of variation in electron donor and oxygen concentrations, microbiologic activity, and sediment texture and mineralogy. Under anoxic conditions, variations in redox potential couple with the biogeochemical speciation of Fe to strongly effect the sorption and transport behavior of certain organic compounds and polyvalent metals and radionuclides. Here we describe results of a laboratory study with subsurface sediments carefully retrieved from an unusual redox transition and fluctuation zone (~18 to 55 m bgs) in an unconfined aquifer at the U.S. DOE Hanford site through which contaminants migrate. The sediments were extracted with weak acid (WA) over time to define acid-soluble Fe(II)_{WA}/Fe(III)_{WA} and co-associated elements (e.g., Si, Al, Mg/Ca, etc). Sediment masses were adjusted to be equal in Fe(II)_{WA}, and kinetic reduction experiments performed in suspension at circumneutral pH with pertechnetate [Tc(VII)O₄⁻(aq)] as a probe reactant. Technetium is a polyvalent radionuclide that is highly sensitive to Fe(II) forms as heterogeneous reductants, and is an important contaminant associated with uranium fission products. Reduction rates normalized to Fe(II)_{WA} varied dramatically between different sediments. The nature of reactive Fe(II) was determined by XRD and SEM/TEM in combination with variable temperature transmission Mossbauer spectroscopy (TMS). Fe(II) smectites and unusual discrete Fe(II) phases were the reductants. The molecular speciation of the Tc(IV) redox product (as determined by EXAFS) was dependent on the reactive Fe(II) form and reduction rate, and varied between Tc(IV)O₂(s) polymers and Tc(IV)-Fe(III) complexes of different type. This speciation, in turn, had a primary influence on the oxidation kinetics of redox product Tc(IV). Microbial characterization of this variable redox zone has been performed and the origin of the various reactive Fe(II) forms will be briefly discussed.

Distinguishing trace element redistribution during mineral reactions from fluid-induced trace element mobility in blueschists

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Exhumed high pressure metamorphic rocks, having experienced conditions of downgoing oceanic crust in subduction zones, offer a rich microchemical and microtextural archive for fluid behavior under such conditions. A particularly large and well-exposed high pressure complex is found in the Western Alpine Sesia-Lanzo Zone (SLZ). Here, clear evidence for widespread fluid infiltration at blueschist-facies conditions can be observed. Chemical modification along grain boundaries and fractures of glaucophane and phengite is visible in high contrast back scattered electron images. Glaucophane core-to-rim zonations show an step-like increase in Fe²⁺ associated with a Mg-decrease, while phengites show a characteristic change towards more celadonitic compositions. Thermodynamic forward models show that the observed compositional trends in glaucophane and phengite are the result of the influx of a hydrous fluid phase at around 40 km during the exhumation of the SLZ.

The trace element zoning patterns differ between metapelitic and metabasic samples. In the metapelites phengite rims have lower concentrations of B, Pb, Sr, Li and Be with respect to the cores. Amphiboles show lower B and Sr, but higher Li and Be concentrations in the rims compared to the cores. In the metabasites phengites show the same trend as in the metapelites, but amphibole have decreasing Sr, Pb and Li from core to rim associated with constant or increasing B concentrations. Trace element mass balance calculations coupled with the thermodynamic forward modelling show that epidote formation during the fluid influx leads to significant redistribution of Sr and Pb within the metapelitic and metabasic samples (closed system) and therefore masks any contribution from the infiltrating fluid (open system). On the other hand, zoning trends of Li, Be and B can not be explained by closed-system element redistribution and must therefore be related to the infiltrating fluid. Comparing trends from different lithologies, it is possible to make inference about the trace element composition of these fluid.

Study of mullite-precursor structure changes type I along with temperature rising

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Mullite (3Al₂O₃.2SiO₂) is an important material in the field advanced ceramics. For the preparation of pure and ultrafine precursors powders, the sol-gel route is a convenient method [1]. The 100°C-dried powders were heat-treated in 100°C and 50°C steps in the range from 950 to 1650°C.

Lattice parameter changes study in this heated range indicates chemical compound changing from Al-rich mullite 2:1 to Al-poor 3:2 mullite.

[1] Fischer, Schneider & Voll (1996) *J. Eur. Ceram. Soc.* **16**, 109-113.

Diffusive reequilibration of quartz hosted silicate melt and fluid inclusions: Are all metal concentrations unmodified?

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We conducted experiments to determine the extent and mechanism by which the composition of quartz-hosted silicate melt inclusions (SMI) and aqueous fluid inclusions (FI) can undergo post-entrapment modification via diffusion. Quartz slabs containing assemblages of SMI and FI were reacted with synthetic HCl-bearing and metalliferous aqueous fluids at T=500-720°C and P=150-200 MPa. SMI from single inclusion assemblages were analyzed by laser ablation inductively-coupled plasma mass spectrometry (LA-ICPMS) and electron probe microanalysis (EPMA) before and after the experiments. Analyses revealed that rapid diffusion of the univalent cations Na⁺, Li⁺, Ag⁺, Cu⁺ and H⁺ occurred through the quartz from the surroundings, resulting in significant changes in the concentrations of these elements in the inclusions. As these elements diffuse as univalent cations, their mobility is limited by the necessity to maintain charge balance. The concentration of Cl (*sensu lato* salinity) cannot be modified in fluid inclusions, but the relative proportions of H, Na, Li, Cu and Ag can easily reequilibrate with subsequent generations of fluids, silicate melts, sulfide liquids, or precipitated sulfide minerals that come into contact with the host quartz. Concentrations of other elements with an effective ionic radius larger than that of Ag⁺, or multiple valence states were not modified in the inclusions during the experiments. Our results warn inclusion researchers that the interpretation of Na, Li, Cu and Ag concentrations from quartz-hosted SMI and FI should be treated critically.

XPS study of stibnite (Sb₂S₃) oxidation

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To properly understand many physical and chemical properties of an important antimony-containing mineral, stibnite, and its geochemical cycle, the stibnite surface should be understood and the nature of stibnite-fluid interfaces should be documented. Recent progress in X-ray Photoelectron Spectroscopy (XPS) technology makes it possible to obtain high-resolution core-level and valence band spectra of many minerals which are semiconductors with large band gaps and non-conductors. This can be used to study mineral surfaces and their reactivity in much greater detail [1,2 and references therein].

We will present our study of the surface chemical species formed upon cleavage of stibnite [1] and upon its reaction with air (days), air-saturated distilled water (days) and 1-3% hydrogen peroxide solutions (minutes and days). The survey, Sb 4d, Sb 3d, and S 2p spectra were collected. The data provide good evidence for the existence of the reduced antimony at the pristine (vacuum cleaved) stibnite surface as a mechanism of the surface relaxation [1]. The stibnite surface reacted with air and hydrogen peroxide undergoes extensive oxidation to give Sb₂O₃ and Sb₂O₅, when reacted with air, and mixed Sb oxide/hydroxide compound when reacted with hydrogen peroxide.

[1] Zakaznova-Herzog *et al.* (2006) High resolution XPS study of the large-band-gap semiconductor stibnite (Sb₂S₃): Structural contributions and surface reconstruction. *Surface Science*, **600/2**, 348-356. [2] Zakaznova-Herzog *et al.* (2008) Characterization of leached layers on olivine and pyroxenes using high resolution XPS and density functional calculations. *GCA* **72**, 69-86.

Coupling of dimethyl sulfide and its contribution to sulfate aerosols in regional climate model: From fluxes to direct radiative forcing

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Dimethyl sulfide (DMS) emission flux scheme is coupled within the framework of the ICTP-Regional Climate Model (RegCM). The sulfur chemistry scheme in RegCM is updated to include the contribution of DMS to the sulfate aerosols formation.

Three sets of experiments are taken into consideration in this study during the period from January 2002 to December 2006. The first one includes the chemistry of biogenic and anthropogenic sulfur compounds taken into accounts DMS oxidation processes and without feedback on climate, the second experiments has the same conditions as the first one and takes into accounts the climatic feedback of sulfate. The third experiment for estimating the contribution of DMS to sulfate without considering the DMS oxidation.

The results show that the contribution of DMS on sulfate aerosols is higher in JJA over the North Atlantic Ocean (with mass burden 0.2 mg/m²), while the lowest contribution recorded in DJF as low as 0.02 mg/m². Some contributions is recorded over the Mediterranean sea.

Silicon isotope variations in the Earth and meteorites

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A fluorhydric acid-free sample preparation method derived from Georg *et al.* [1] has been used to measure the natural variations of silicon isotope compositions in terrestrial (including 12 geological standard materials) and meteoritic bulk-rock samples.

All measurements were done using a Neptune MC-ICP-MS in medium resolution mode ($m/\Delta m = 7000$, peak-edge definition). Magnesium was used as internal standard for mass-bias drift correction. The $\delta^{30}\text{Si}$ values are expressed relative to the NBS-28 silica standard.

IRMM-17 reference material yields a $\delta^{30}\text{Si}$ of $-1.4\text{‰} \pm 0.05\text{‰}$ (2SD, $n=11$) in agreement with previous data [2-3]. Long-term reproducibilities were obtained for BHVO-2 ($\delta^{30}\text{Si} = -0.27\text{‰} \pm 0.08\text{‰}$ (2SD, $n=30$)) and a in-house Si standard ($\delta^{30}\text{Si} = -0.01\text{‰} \pm 0.07\text{‰}$ (2SD, $n=20$)) on a 7 months time scale.

Total variation of $\delta^{30}\text{Si}$ in natural samples ranges from -0.5‰ to -0.1‰ . Comparison with $\delta^{29}\text{Si}$ values shows that this isotopic fractionation is mass-dependent. A 0.2‰ isotopic variation occurs among terrestrial samples suggesting an enrichment in the heavier silicon isotopes as a function of magma differentiation, as initially hinted by Douthitt [4]. Terrestrial samples mean value ($\delta^{30}\text{Si}_{\text{Earth}} = -0.23\text{‰}$) is heavier by about 0.24‰ in $\delta^{30}\text{Si}$ compared to chondrites. This may be explained by silicon isotope fractionation during planetary accretion and/or differentiation.

[1] Georg *et al.* (2006) *Chem. Geol.* **235**, 95-104. [2] Chmeleff *et al.* (2008) *Chem. Geol.* **249**, 155-166. [3] Ding *et al.* (2005) *Chem. Geol.* **218**, 41-50. [4] Douthitt (1982) *GCA* **46**, 1449-1458.

The organic nitrogen fraction of deposition over the North Atlantic

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The input of atmospheric nitrogen to the oceans is increasing because of anthropogenic alteration of the nitrogen cycle. Because of its proximity to land, the oligotrophic North Atlantic subtropical gyre in particular may receive enough new N from deposition to enhance new production and possibly to push the system towards P limitation [1,2]. However, estimates of nitrogen deposition to the ocean are still highly uncertain because of the dearth of deposition measurements in marine environments and the limitations in the range of N species measured. Of particular interest are water soluble organic nitrogen (WSON) compounds that, based on early estimates, could contribute around 30% of the ocean nitrogen deposition flux [1,3] and may be bioavailable. However WSON data are few in number and they are temporally and spatially limited.

Here we present the results of measurements of atmospheric WSON in wet deposition and aerosols which were sampled continuously in Miami and periodically in Barbados during 2007 - 2008. Deposition of WSON was approximately 3.3 and 2.0 mmol N m⁻² yr⁻¹ in Miami and Barbados, respectively, and attributed only ~10% of the total soluble N deposition. Because of the dominance of marine air masses at our sites, the low fraction of WSON to total soluble N we observed may be more representative of deposition over the oceans than measurements taken at sites more influenced by terrestrial sources. Our results support the conclusion that the assumption of 30% WSON in N deposition is not appropriate for the North Atlantic.

[1] Duce *et al.* (2008) *Science* **320**, 893-897.
 [2] Krishnamurthy *et al.* (2007) *JGR* **112**, G02019, doi:10.1029/2006JG000334. [3] Jickells (2006) *Biogeosci.* **3** 271-280.

Chemical and isotopic relationship between matrix and chondrules in ordinary and carbonaceous chondrites

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The oxygen isotopic composition of chondrites may be interpreted in terms of mixing of chondrules, refractory inclusions (RI) and matrix [1]. At the time of accretion, ¹⁶O abundance variations (expressed in terms of $\Delta^{17}\text{O}$) must have been carried by chondrules and RIs, whereas mass fractionation (expressed in terms of $\Delta^{18}\text{O}$) was carried by the matrix. RIs and chondrules are high temperature components and hence depleted in volatiles, whereas matrix is expected to be the seat of these species as well as of presolar grains.

Beyond these broad lines, the specifics remain poorly understood: it is unclear (a) how chondrule compositions vary between chondrites or chondrite groups and what fraction of the volatile elements they do carry (b) whether matrix presolar grain and volatile element abundances vary - with the possibility of a matrix-chondrule complementarity as advocated by [2] - or (c) whether the volatile element budget of chondrites is exclusively determined by their relative proportions of matrix and high T components.

We studied the volatile element and presolar grain content of bulk chondrites as a function of their matrix modal abundance and $\Delta^{18}\text{O}$. We show that the budget of presolar diamonds and of the most volatiles species (H₂O, C, N) in the least metamorphosed chondrites is entirely determined by their matrix abundance. The case for less volatile elements is more complex. Some of them (e. g. Au) appear to be present in chondrules as well as in the matrix. S is present in the chondrules of OCs but not of CCs indicating that, even if abundance of high T components vs matrix is responsible for the first order variations of volatile element abundances, changes in chondrule compositions determine a second order of volatile element variations. A complementarity of compositions between chondrules and matrix cannot be ruled out.

[1] Zanda *et al.* (2006) *EPSL* **248**, 650-660. [2] Bland *et al.* (2005) *PNAS* **102**, 13755-13760.

Rates of magmatic processes from U-series in historical eruptions at Askja and Krafla volcanoes, Iceland

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Following our recent study on late Holocene rhyolite melt generation processes and their rates at Torfajökull Central Volcano in Iceland's Southern Flank Zone [1], we now present data from the actively rifting Eastern Rift Zone. There, Askja and Krafla Central Volcanoes have produced rhyolites in historic times. At Askja, we studied major, trace and U-Th-Ra isotope geochemistry of the 1875 bimodal deposits and the possibly cogenetic [2] Sveinagja lava flow, and of the 1929 and 1961 basalts. At Krafla, we focussed on the Myvatn Fires eruptions, studying major, trace and the U-Th-Ra isotope geochemistry of the 1724 bimodal Viti deposits and the 1727-29 Myvatnseldar basalt lava.

At Askja and Sveinagja, all WR samples plot in Th excess, with $1.04 \leq (^{230}\text{Th}/^{232}\text{Th}) \leq 1.07$ and $0.91 \leq (^{238}\text{U}/^{232}\text{Th}) \leq 0.92$ for basalts compared to $(^{230}\text{Th}/^{232}\text{Th}) \approx 0.96$ and $(^{238}\text{U}/^{230}\text{Th}) \approx 0.89$ for the 1875 rhyolite. At Krafla, the basalt and rhyolite $(^{230}\text{Th}/^{232}\text{Th})$ activity ratios are ~ 1.10 and ~ 0.99 , respectively, but basalts plot closer to the equiline with $1.08 \leq (^{238}\text{U}/^{232}\text{Th}) \leq 1.09$ compared to the rhyolite with $(^{238}\text{U}/^{230}\text{Th}) \approx 0.91$. Askja samples display ^{226}Ra - ^{230}Th equilibrium or slight ^{226}Ra excesses, and the Sveinagja lava flow yields $(^{226}\text{Ra}/^{230}\text{Th}) \approx 1$. At Krafla, $(^{226}\text{Ra}/^{230}\text{Th})$ activity ratios are ~ 1.2 and ~ 1.0 for the Myvatnseldar basalt and the Viti rhyolite, respectively. In order to constrain rhyolite melt generation and crystallization ages, we are in the process of analysing U-Th-Ra isotopes of px and mt separates from the 1875 Askja rhyolite and of mt and plag separates from the 1724 Viti rhyolite. A px mineral separate from the 1875 Askja rhyolite yields a zero age U-Th isochron with its WR, providing preliminary evidence that there, as in Torfajökull Central Volcano [1], melting produced evolved compositions during the Holocene.

[1] Zellmer *et al.* (2008) *EPSL* **269**, 387-397. [2] Sigurdsson & Sparks (1978) *Bull. Volc.* **41**, 149-167.

Earth-Moon impacts over ~4.5 Ga

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Lunar Impact Glasses

Lunar impact glasses offer the potential for providing compositional information about local and remote areas of the Moon [1, 2, 3] and may also place constraints on the impact history in the Earth-Moon system.

Previous studies have reported $^{40}\text{Ar}/^{39}\text{Ar}$ ages on lunar samples (i.e., rock fragments, meteorites) in order to provide evidence as to whether or not a lunar cataclysm occurred ~ 3.9 Ga (e.g., [4, 5]). We present $^{40}\text{Ar}/^{39}\text{Ar}$ ages on Apollo 14, 16, and 17 impact glasses to show differences in impact events, when time and space (i.e. sample provenance) are considered.

Results

Of the 65 lunar impact glasses for which these authors have found an age, samples with ages >4000 Ma are rare or absent, as is true for Apollo impact rocks [6], impact melts from lunar meteorites [5], and other lunar impact glass data sets [e.g. 7]. Additionally, few show ages consistent with a recent increase in the impact flux, as reported in (e.g. [7]).

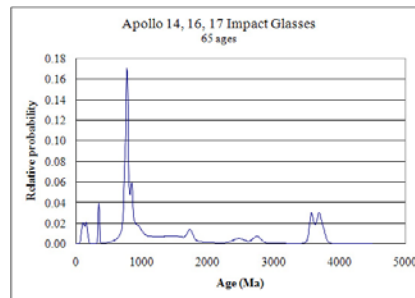


Figure 1: Ideogram of lunar impact glass ages. Each age is represented by a Gaussian distribution of unit area; precisely determined ages appear as tall spikes and poorly determined ages appear as low, broad humps.

By integrating geochemistry and age [3], multiple impact samples formed at the same time in the same terrain can be removed from the data set. The challenge comes in trying to distinguish among the impact events, including determining which samples (impact glasses, melt rock, meteorites) were formed during the same impact event and which were not, so that the impact flux is not artificially inflated.

[1] Delano (1991) *GCA* **55**, 3019-3029. [2] Zellner *et al.* (2002) *JGR* **107(E11)** 5102, doi:10.1029/2001JE001800. [3] Delano *et al.* (2007) *MAPS* **42** (6), 993-1004. [4] Tera *et al.* (1974) *EPSL*, **22**, 1021. [5] Cohen *et al.* (2005) *MAPS* **40**, 755-777. [6] [11] Bogard (1995) *Meteoritics* **30**, 244-268. [7] Levine *et al.* (2005) *GRL* **32**, L15201.

Melt-rock interactions during the early stages of rapid exhumation of a deeply subducted continental slab

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Polyphase inclusions of K-feldspar + quartz + sphene were founded in both omphacite and garnet from the Sulu ultra-high pressure eclogites. These inclusions have clear cut boundaries with their host and display irregular internal textures. Each of the fifteen identified inclusions is unique in its shape and modal contents of K-feldspar (Kf; 18-85%), quartz (Qtz; 8-78%) and sphene (Sph; 11-38%). Reconstructed bulk compositions have SiO₂ ranging from 56.6 to 91.0 wt%, Al₂O₃ from 3.4 to 15.4 wt%, K₂O from 3.0 to 14.2 wt%, CaO from 0.4 to 10.8 wt%, and TiO₂ from 0.5 to 12.5 wt%. We interpret these inclusions as products of reaction between K-rich haplogranitic melt and quartz (coesite) aggregates, generating a range of compositions according to the degree of progress of this reaction. The hybrid melts subsequently migrated into a mafic assemblage and were trapped during dynamic recrystallization of the major eclogite minerals. This hypothesis implies that either a melt rich in K and Si or a supercritical fluid was present during the subduction and exhumation of the Sulu UHP slab, at a stage preceding the end of eclogite facies conditions. The fluid phase must furthermore have been sufficiently mobile to pass from its host lithology through both silica-saturated and mafic regions of the continental slab. Although the initial fluid may have transported only fluid-mobile (LILE) elements, evidently the final hybrid melt carried enough Ti to crystallize sphene and hence transported also fluid-immobile (HFSE) elements during the exhumation of the continental slab. Furthermore, if the mobile phase began as a hydrous fluid, by the time the hybrid melt or cumulate minerals from the hybrid melt were trapped, water activity had reached low enough values to avoid the precipitation of any hydrous minerals.

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Metastable phase equilibria for the aqueous system containing lithium, sodium and sulfate at 273 K

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Introduction

Zabuye Salt Lake, Tibet, is one of the carbonate alkaline lakes famous for its high concentrations of sodium, potassium, lithium and borate. The system containing lithium, sodium and sulfate is one of subsystem of Zabuye Salt Lake brine and its phase equilibria at 273 K has not been reported yet. In this paper, the metastable equilibria of this system were studied at 273 K using an isothermal evaporation method.

Discussion of Results

Figure 1 is the metastable phase diagram of the system. The diagram consists of three univariant curves and three crystallization fields corresponding to single salt Li₂SO₄·H₂O, Na₂SO₄·10H₂O and the double salt 3Na₂SO₄·Li₂SO₄·12H₂O, respectively. One invariant point is saturated with salts Na₂SO₄·10H₂O and 3Na₂SO₄·Li₂SO₄·12H₂O, and the mass fraction of its equilibrium solution is w(Li₂SO₄) 23.22 % and w(Na₂SO₄) 6.91%; the other invariant point is saturated with salts Li₂SO₄·H₂O and 3Na₂SO₄·Li₂SO₄·12H₂O, the mass fraction of equilibrium solution is w(Li₂SO₄) 24.62 % and w(Na₂SO₄) 5.56 %.

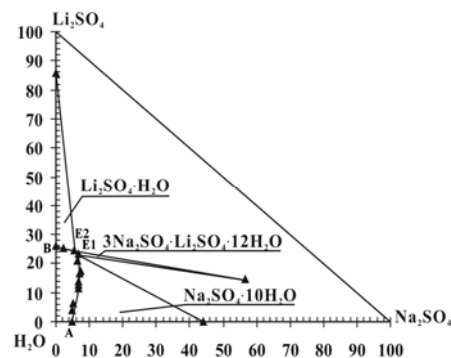


Figure 1: Metastable phase diagram of the system containing lithium, sodium, and sulfate at 273 K.

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Biogeochemical sulfur cycling in meromictic Fayetteville Green Lake, NY

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Green Lake (GL) is a small, permanently stratified freshwater lake located approximately 2 km northeast of Fayetteville, NY. The input of sulfate-rich groundwater at depth sustains density stratification and results in high sulfate concentrations (12 – 15 mM) and the build-up of hydrogen sulfide in bottom waters. As such, GL represents a high-sulfate contrast to low-sulfate systems currently being studied as Precambrian ocean analogues, and could be appropriate in thinking about euxinic systems that have been proposed for more recent Phanerozoic oceanic anoxic events occurring after an initial rise in marine sulfate. We measured concentrations of major sulfur species and S isotope values ($\delta^{34}\text{S}$ and $\Delta^{33}\text{S}$) of sulfur compounds in the GL water column in November 2007 and October 2008, in an attempt to quantify the major biological and inorganic processes controlling sulfur cycling in the system. Sulfide concentrations are at or near the detection limit above the chemocline (< 20 m depth), but increase to > 1.5 mM in bottom waters. A peak in total zero valent sulfur (up to ~30 $\mu\text{M S}^0$) occurs at around 20.5 m, coincident with a peak in turbidity representing a dense community of phototrophic S-oxidizing bacteria. $\delta^{34}\text{S}$ values of sulfide and sulfate in the GL water column are consistent with previous studies (increasing slightly with depth), with the important exception that we measure a *decrease* of ~4 ‰ in the $\delta^{34}\text{S}$ of sulfide with increasing depth across the chemocline (from 20 – 22 m). This trend suggests that inorganic oxidation of sulfide to ^{34}S -depleted sulfur intermediates (e.g., thiosulfate) is controlling the isotopic composition of sulfide in the chemocline, rather than phototrophic oxidation to S^0 , which is enriched in ^{34}S by ~6 ‰ (consistent with the predominance of polysulfides). Additionally, mass balance models of $\delta^{34}\text{S}$ and $\Delta^{33}\text{S}$ values at depth indicate that both sulfate reduction and sulfur compound disproportionation metabolisms are contributing to the isotopic composition of sulfide in the deep waters.

Modeling of fluid phase equilibria for H_2S - H_2O mixtures to 400°C

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Hydrogen sulphide plays an important role in the complexation and transportation of metals, notably gold, in hydrothermal liquids. As a result of numerous experimental studies, this role is relatively well understood, and data are available that permit satisfactory quantitative modelling of ore-forming processes involving H_2S -bearing liquids. However, in magmatic hydrothermal systems, vapour can be an important and even dominant fluid and, as H_2S partitions strongly into the vapour, it is therefore important that we also develop a capacity to model ore-forming processes involving this phase. Unfortunately there is a dearth of data for H_2S - H_2O gas-liquid mixtures at elevated temperature and pressure. Furthermore, most of the experimental PVTx data available for this system, were obtained at low temperatures and partial pressures of H_2S . Consequently the equations of state that have been developed from these data are inaccurate in predicting phase relationships for H_2O - H_2S mixtures at high temperature and elevated partial pressures of H_2S .

The goal of our study was to collect the experimental data required for a detailed description of vapour-liquid equilibria in the H_2S - H_2O system for a wide range of partial pressures of H_2S at temperatures up to 400°C and pressures up to 300 bar. Experiments were performed in a titanium-alloy constant-volume cell equipped with a sapphire pressure sensor. The sensor was connected to the cell through a custom-made mercury-filled transducer equipped with a titanium membrane, permitting accurate measurement of pressure at the temperature of the experiments.

The new VLE model developed using the data collected employs an asymmetric γ - ϕ approach, i.e., the fugacity of the vapour is described using fugacity coefficients obtained from an equation of state and the fugacity of the liquid is derived from thermodynamic data and an appropriate activity coefficient model. The properties of the vapour were calculated using the Stryjek-Vera modification of the Peng-Robinson cubic equation of state. Binary interaction parameters for the mixture of water and hydrogen sulphide were fitted to a set of high-temperature experimental data.

The resulting model provides the framework required for reliable future modelling of two phase hydrothermal systems such as those responsible for the formation of porphyry and epithermal mineral deposits.

The metamorphic ages and PT paths of the HT-HP and HT-UHT granulites in North China Craton

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High-grade metamorphic rocks are extensively distributed in the North China Craton (NCC), and study on high-temperature and high-pressure granulites (HT-HP) and high-ultra-high temperature granulites (HT-UHT) is a key issue to understanding the Early Precambrian tectonic evolution. The HT-HP granulites are mainly garnet-bearing mafic granulites that are metamorphosed and deformed dykes enclosed in the orthogneisses. The HT-UHT rocks are metamorphosed pelites (khondalites), and sapphirine and spinel in khondalite indicates metamorphic temperature > 900-1000 °C. This study deals with the occurrences, distribution, metamorphic conditions and history, isotopic ages of the two granulites, and emphasizes the following aspects: (1) the peak metamorphic conditions and *PT* paths with a relief of pressure for two granulites are similar; (2) their metamorphic ages of the peak and followed decompressional stages are also similar, which are ~1930-1900 Ma and 1860-1820 Ma, respectively; (3) HT-HP and HT-UHT granulites probably occur in area distribution other than in linear distribution; (4) high-grade granulites represent the Precambrian lowermost crust. Therefore, the metamorphic geological setting and their original for the two granulites are most important in the future study.

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Research on the organic geochemistry for Chipu Pb-Zn deposit, Sichuan, China

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Introduction

A great deal of bitumen and lead-zinc sulfides hosted by carbonate rocks grows together in Chipu deposit. In addition, many organic fluid inclusions develop in quartz and sphalerite. So, Chipu Pb-Zn deposit have closely associated with the organic matter. Through separation of compound-grouped fractions and content determination, saturated hydrocarbons chromatogram-mass spectrum analysis of organic matter, the organic fractions and biomarker of bitumen have been researched on. In last part, we discussed the roles during mineralization and geological significance.

Conclusions

Existence of C₃₀ sterane, low Pr/Ph, Pr/nC₁₇ and main peak of n-alkanes, indicate that organic matter source is marine sediment rather than continental deposits. It's mainly from carbonate rocks and minor from the shale. This kind of characteristics of mixed origin could be formed by different sources of ore-forming fluid.

OEP<1, C₃₀*/C₂₉Ts<0.6 and high rate of gammacerane implies that organic hydrothermal fluids suffered the physical and chemical processes of high reduction and high salinity.

With similar high maturity, organic matter in sulfide and host rocks belongs to carbon bitumen with the evolution of higher level. They both underwent similar geological process.

The high methane content in fluids inclusion in sulfides inferred that high mature stage of organic matter evolution. The oil and gas reservoir maybe involved during mineralization. The sulfate in carbonate rocks can be reduced by organic matter to create reduced sulfur for lead and zinc sulfide precipitation. So, organic matter may play a role of reducing agent during meteoric water mixing with ore-bearing fluid.

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SHRIMP U-Pb zircon geochronology of the Tieshajie Group in the Cathaysia Block-China: Implications for Neoproterozoic tectonic significance

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The tectonic relationship between the Yangtze plate and Cathaysia during Neoproterozoic has been paid a lot of attention by many studies [1]. And thus, there are a few isotopic dating results about metamorphic rocks from the both plates. In order to interpret the tectonic setting clearly, it's necessary to get enough new isotopic ages from the metamorphic rocks in the studying area.

The Tieshajie Group is located on the northwestern Cathaysia and is close to the southeastern margin of the Yangtze Plate. This Group consists of two kinds of rocks which are meta-sedimentary and metavolcanic rocks. There were several dating results about the meta-sedimentary rocks such as 1159Ma (Rb-Sr isochrone dating) and 1201 Ma, 1162Ma and 1091Ma (single zircon U-Pb dating), from which the Tieshajie Group were considered as the mesoproterozoic. In this study, we selected two samples from meta-sedimentary and metavolcanic rocks respectively for zircon SHRIMP U-Pb dating. Zircons from metasedimentary rock appear round shape, while zircons from metavolcanic rock are euhedral or subhedral. New SHRIMP U-Pb zircon dating results for the Tieshajie Group are present, including 1153 ± 38.4 Ma for the metasedimentary rock, 902 ± 23 Ma for the metavolcanic rock.

From the above new dating results, it is concluded that the age of metavolcanic rock may represent the formation age of the Tieshajie Group, which was coincident with the Neoproterozoic collision between Cathaysia and Yangtze Blocks. (Grant Nos. 1212010813064 and 1212010533105).

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The H, O isotopic characteristics and mineralization age of the Baishan molybdenum deposit in Eastern Tianshan

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Geochemistry of the Baishan deposit

The Baishan Mo deposit is located in the eastern section of Jueluotag tectonic belt, Eastern Tianshan, Xinjiang, China. The H, O compositions of hydrothermal fluids in the ore-bearing quartz veins are: $\delta^{18}\text{O}_{\text{H}_2\text{O}}$ 3.36‰ ~ 5.33‰; $\delta\text{D}_{\text{SMOW}}$ -105‰ ~ -56.30‰. The Re-Os isochronal age of seven samples of molybdenite is 227.7 ± 4.3 Ma (MSWD=0.32).

Discussion

The H, O compositions indicate that the ore-forming hydrothermal solution were mainly from magmatic water and some meteoric water which comply to the reference [1], the result shows that the ore-forming material of the Baishan deposit is mainly from the granite body.

There is a common agreement on the main post-collisional stage in northern Xinjiang in the late Palaeozoic [2][3][4], the age of mineralization of the Baishan deposit is in the middle Trias which may be the mineralization of the terminal post-collisional stage.

Conclusion

The ore-forming material of the Baishan Mo deposit is mainly from the granite body which formed in the tectonic setting of the late post-collisional stage in northern Xinjiang.

This research was sponsored by the National Key Basic Science Research project of China (2007CB411304 and 2001CB409806) and the National Natural Science Foundation of China (40772057).

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Geochronology of the Sanggan potassic granites in the Northern China Craton

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The Precambrian Sanggan potassic granites in the northern China Craton are mainly composed of leucosyenogranite, biotite-monzogranite, and garnet-syenogranite. Zircon U-Pb dating was carried out by methods of SHRIMP and LA-ICP-MS for three types of the granites. The leucosyenogranite and biotite-monzogranite have U-Pb ages of 2493 ± 6 Ma and 2437 ± 10 Ma, respectively. Whereas the garnet-syenogranite yields slightly younger ages of 1977 ± 18 Ma and 2003 ± 24 Ma. In addition, metamorphic zircons from two garnet-syenogranite samples gave mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 1813 ± 21 Ma and 1818 ± 27 Ma. Therefore, the Sanggan potassic granites were generated by multiple tectono-thermal events and underwent late paleoproterozoic high grade metamorphism. The 2500-2400 Ma felsic intrusions were generated by amalgamation of microblocks, whereas the 2000 Ma metamorphism was probably resulted from intra-continental rifting [2].

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REE partitioning between peraluminous melt and coexisting aqueous fluid

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Experiments and Results

Partitioning coefficients of 12 REEs and Y between peraluminous melt and coexisting aqueous fluid were determined in the fluid-saturated experiments at 100 MPa and 800°C. All runs were conducted in externally heated cold-seal pressure vessels using water as a pressure medium for the durations of 144 hours. The experimental results show that REE partitioning coefficients ($D_i^{\text{fluid/melt}}$) are ranged from 0.1×10^{-4} to 19.9×10^{-4} , and decrease gradually as increasing of atomic number of REE from La to Lu, showing a trend of $D_{\text{LREE}} > D_{\text{MREE}} > D_{\text{HREE}}$.

Discussion of Results

Highly differentiated peraluminous magmatic rocks are characterized not only by significant REE tetrad effect, but also by obvious fractionation of equivalent incompatible elements pairs, such as Y-Ho [1-3]. Up to now, it is commonly considered that REE tetrad effect originates from the interaction of peraluminous melt with aqueous fluid [2, 4-5]. As no fractionation between Y and Ho is shown in this study, we put forward here that magmatic-hydrothermal transition system is impossible as a fundamental mechanism for REE tetrad effect in peraluminous magmatic systems.

This work was financially supported by National Basic Research Program of China (973 Program) (2007CB411303), and Chinese National Natural Science Foundation (40673052).

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Discussion on pre-Mesozoic basement in Hefei basin, western Tan-Lu fault belt

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Tan-Lu belt is an important slide-slip fault system in east China continent, its movement and tectonic characteristics are intensively studied by Chinese experts from various aspects (e.g., [1-5]). The basement age of Hefei basin co-existing with this gigantic fault system remains unknown due to the very deep Mesozoic red sedimentary accumulation of land facies (c.a. 5000-10000m).

In this study, we obtained sequences of samples of the basement in Hefei basin, 20 km away western Tan-Lu fault belt with an deep drill of Ancan Drill I with the large-scale exploration for oil and natural gases operated by Shengli Oil Field Co. Ltd, China. Drill Ancan-I is the only ultra deep drill in the Southern North China basin, correct understanding of pre-Mesozoic stratum is very useful for the study of theory and mineral prospecting. Reliable stratigraphic markers, such as paleontologic evidence, have not find in drill sample. Based on geotectonics, geophysics, and geochemistry, and the correlation of lithology, thickness, geophysics and geochemical indicator, the study suggests that the dark claystone in Drill Ancan-I, under the exposure level of Indo-China movement, is similar to Qingbaikou System, different from Permo-Carboniferous.

This study is supported by the National Natural Science Foundation of China (Grant No.: 90814008).

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Coccolithophorids blooms and their biogeochemical-controlling features: Varied water masses and nutrient fluxes in the southeastern Bering Sea

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After 1997, coccolithophorid blooms were frequently observed on the eastern Bering Sea shelf, where diatoms have had the most dominate distribution. The recent climate change has dramatically altered the water mass characteristics. Here, we present CTD, Chl-a, nutrients and phytoplankton data, oxygen isotope compositions (0.005 ‰) and rare earth element concentration collected on R/V *Mirai* (MR00-K06, MR01-K04 leg2, and MR06-K04 leg2) and T/S *Oshoro-Maru* (OS105, OS115, OS124 and OS159) cruises. Our goal is to clarify the relationship between changes in distribution of coccolithophorids and water mass composition. The linkage leads to understanding the connection between climate change and impact on a biogeochemical system.

The water mass structure is divided into three domains, separated by density fronts. These water masses are defined by their origins: Pacific water (Outer), cold water mass (Middle), and river water (Inner). The appearance of *E. Huxleyi* is well correlated with the nutrient supply and consumption from summer to autumn. Therefore, the distributions of coccolithophorid are controlled by the spatial variations of water mass linked with nutrients, which are controlled by the strength of the density stratification on the shelf and the fractions of cold water mass and the riverine influence.

Updates in the aerosol-climate model ECHAM5-HAM and their effects

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Faithful simulations of the aerosol effects on climate require a realistic representation of aerosol mass and number concentrations as well as the size distribution of aerosol particles. In this work we attempt to quantify changes in the simulated aerosol distribution caused by various updates in the parameterization schemes of the global aerosol-climate model ECHAM5-HAM.

Since its first version developed by Stier *et al.* [1], ECHAM5-HAM has gone through further developments. The modifications include (1) a new time integration scheme for the condensation of the sulfuric acid gas on existing particles (Kazil *et al.* 2009), (2) a new aerosol nucleation scheme which takes into account the charged nucleation caused by cosmic rays (Kazil *et al.* 2009), (3) an updated water uptake scheme for calculating the hygroscopic growth of aerosol particles (O'Donnell, 2009), and (4) a parameterization scheme explicitly describing the conversion of aerosol particles to cloud nuclei. Our analysis reveals that all these new treatments have resulted in significant changes in the model results. The simulated aerosol number concentrations and size distributions have improved in many aspects. Examples will be shown in the presentation. The corresponding changes in the simulated climate forcing will also be discussed.

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Characteristics of hydrothermal alteration in the Shaxi Porphyry Cu- Au deposit, Anhui Province, China: Paragenesis and geochemical

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Shaxi porphyry Cu–Au deposit is located at the northwest of Lu (Lujiang)–Zong (Zongyang) volcanic basin, Anhui Province, China, is a large porphyry Cu–Au deposit. The main ore-bearing rock of the deposit is quartz diorite porphyry. Hydrothermal alteration zones are similar to those recognized as forming in porphyry Cu–Au deposits worldwide. Studies of alteration mineral chemistry at Shaxi porphyry Cu–Au deposit have revealed some important informations that may assist exploration.

The major alteration minerals at Shaxi porphyry deposit are arranged in a complex series of zones passing away from the deposit–potassic alteration zone (K–feldspar, Biotite), K–silicate and propylite overprint alteration zone (K–feldspar, biotite, epidote, chlorite)–quartz sericite alteration zone (quartz, sericite, pyrite)–propylite alteration zone (epidote, chlorite, carbonate) (from the inside to the outside). The Cu–Au mineralization occurs in the potassic alteration zone and K–silicate and propylite overprint alteration zone.

The alteration process has resulted in the decrease of ΣREE and increase of LREE/HREE. The differentiation of LREE to HREE of altered rock and the alteration index $100 \times (\text{K}_2\text{O} + 1000\text{Rb}) / (\text{K}_2\text{O} + 1000\text{Rb} + \text{CaO} + 100\text{Sr})$ can be used as an indicator for Cu–Au mineralization at Shaxi porphyry deposit.

This research was supported by the National Natural Science Foundation of China (40672062, 4083042 and 40803015) and Major State Basic Research Development Program of China (2007CB411405).

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Studies on P-T-t of mafic granulites from north Tongbai, central China

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Detailed studies on petrology and mineralogy of the mafic granulites from north Tongbai area indicate that the peak metamorphic condition was at 880~900°C and ca. 1.1GPa. LA-ICP-MS U-Pb metamorphic zircon dating of the mafic granulite yielded weighted mean $^{206}\text{Pb}/^{238}\text{U}$ concordia age of 418.7±3.2Ma. According to the Zr saturation model, Zr was not saturated in melts at peak metamorphic condition and would be saturated when cooling to 750~800°C, calculated by partial melting modeling. Additionally, Ti-in-Zircon geothermometer also gives the crystallization temperature of ca. 750°C. These suggested that the age of 418.7Ma is not the age of peak metamorphic condition, and probably is a record for the time when cooling to 750~800 °C. The age of peak metamorphism could be around 430~445Ma. LA-ICP-MS U-Pb zircon dating of the acidic granulite also yielded the peak metamorphic age of 430~445Ma. Some zircon grains have obvious overgrown rims, with stronger Cathodoluminescence and higher common Pb than the core. The rims and high common Pb zircons domain yield a age of 404.7± 6.5Ma, indicating that the mafic granulite suffered a retrograde metamorphism at about 404 Ma. We suggest that the high-temperature mafic granulites from north Tongbai area were probably formed in residual overthickened crustal basement in continental subduction-collision zones or arc-continent collision belts.

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Role of sulphur in hydrocarbon formation of Paleogene lacustrine source rocks in the Jiyang Depression, East China

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In the Jiyang Depression in East China, the Paleogene source rocks were formed in saline and fresh water environments [1]. On the basis of the comparison between experimental simulation and geologic profiles, saline water source rocks have two hydrocarbon-formation zones as early and late stages, while fresh water source rocks have only one zone as late stage.

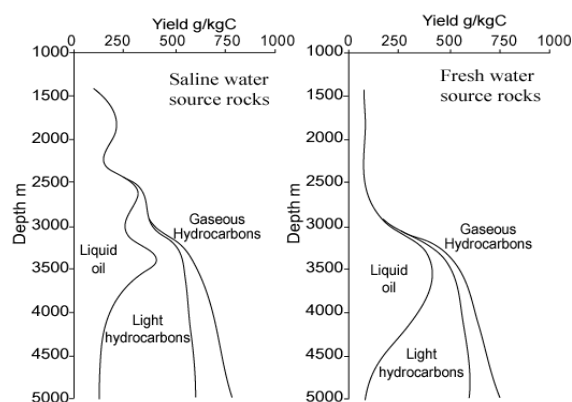


Figure 1: Hydrocarbon generation schemes.

The difference of hydrocarbon formation is mainly due to the organic facies of source rocks. Hydrocarbon formation thresholds strongly correlate with organic sulphur contents [2]. The sulphur contents in the kerogen of saline water source rocks are 3.2%-14.7% (main range 6-9%). Those of fresh water source rocks are 1.05%-4.90% (main range 1-3%). The S-C bond has a relatively low energy. The typical samples of saline water and fresh water source rocks were calculated to be 177.77 kJ/mol and 190.37 kJ/mol in hydrocarbon transformation activation energy, respectively.

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Time series data reduction for the Chang'E-1 Gamma-ray Spectrometer

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Introduction

The Chang'E-1 Gamma-Ray spectrometer(CE1-GRS) is developed by Purple Mountain Observatory, Chinese Academy of Sciences. Its heart is a 118mm diameter by 78mm long cylinder of CsI. The CE1-GRS CsI crystal measures gamma-ray having energies from 0.3 to 8.9MeV. The measured energy resolution is 8.27% at 662keV and scales as $E^{1/2}$ (where E=gamma-ray energy). The spectra is measured with 512 channels. The collection time for main crystal is 3 seconds. The main crystal is surrounded by 3mm thickness anticoincidence crystal of CsI.

Primary Processing

CE1-GRS have returned a great deal of gamma-ray data from the Moon. It is importance to provide a thorough description of CE1-GRS data reduction processes that convert raw counts rate data into fully corrected time-ordered gamma-ray spectra that are used to directly derive elemental maps. This processing includes steps such as channel processing, deadtime correction, gain correction, energy calibration, geometric correction, orbit altitude normalization, galactic cosmic ray correction and binning data into equal-area pixels.

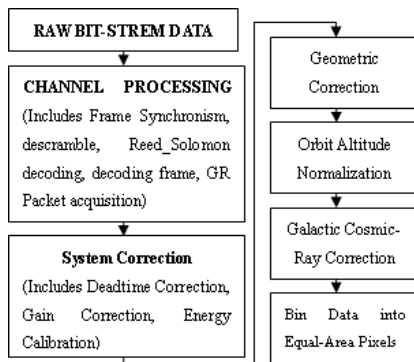


Figure 1: Data reduction summary flowchart

[1] Lawrence *et al.* (2004) *JGR*. **109**, E07S05, 245-254. [2] Reedy *et al.* (1973) *JGR*, **78**(26), 5847-5866. [3] Reedy *et al.* (1972) *JGR*. **77** (4),537-555.

Adhesion of *Shewanella oneidensis* MR-1 to iron (oxy)(hydr)oxides: Microcolony formation and isotherm

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Understanding the physical attachment of dissimilatory metal reducing bacteria to a mineral substrate may be critical to understanding the rate and extent of respiration. Here, the adhesion of *Shewanella oneidensis* MR-1 cells to mineral surfaces was examined using a novel confocal microscopy method and a live-dead dye. Specifically, planar iron (oxy)(hydr)oxide particulate coated glass slides were used that allowed us to directly observe adhered cells and revealed their spatial distribution. We quantitatively estimated cell surface density at bulk densities ranging from 10^5 cells/mL to 2×10^9 cells/mL. It was found that adhered cells formed microcolonies at bulk cell densities larger than $\sim 10^8$ cells/mL, whereas at lower bulk densities, the adhered cells formed an evenly distributed, homogeneous monolayer. Due to this complexity, the overall attachment behavior was not modeled well with either a simple Freundlich or Langmuir isotherm over the entire range of bulk cell densities. At low bulk cell densities, the cell adhesion behavior was modeled well by a Langmuir isotherm. To account for the microcolony formation above a critical bulk cell density, a second Freundlich-type isotherm was then added in a feedback mechanism to realistically describe the relationship between adhered single cells and microcolonies.

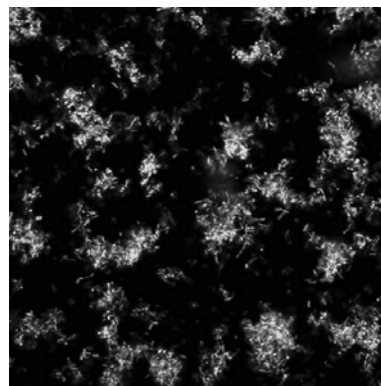


Figure 1: Microcolony formation at bulk cell density 1×10^9 cells/mL.

FT-IR spectra of NaCl-H₂O at high temperatures upto 650 °C

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Observations of aqueous solutions and their molecular spectra at high temperatures and pressures were performed using a new design hydrothermal diamond anvil cell (HDAC), connected to both a light and an infrared microscope. We have modified the diamond window of HDAC with a wide angle, to allow the infrared beam to pass the window. FT-IR spectra of NaCl-H₂O-D₂O has been examined at high temperatures up to 850°C and 3 GPa. Rising temperature effects on water spectra is different with increasing pressure. As phase transition H+L+V → L+V → L or F of NaCl-H₂O (39wt%NaCl), the spectra were measured from 29 to 650°C. There remains one liquid phase as T>467°C. From 29 to 300°C a wide band from 3200 to 3700 cm⁻¹ reflects a deconvoluted spectrum of O-H stretching vibrations corresponding to the hydrogen bond (HB) and the non-hydrogen bond (NHB). At 330°C, a big shape peak of O-H stretching vibration was reached at 3623 cm⁻¹. The sharp and strong O-H stretching vibration at 330°C near the critical state of water proves the breakdown of the hydrogen bonding net work. Above 330°C, the O-H symmetric stretch vibration corresponded to NHB predominates. The OH stretching vibration frequency increases with increasing temperature: from 3623 to 3659 cm⁻¹ (ν₁+ν₃). Also the combined OH stretch and HOH bend frequencies increase with temperature. Anion effects on the vibration frequency of water molecules of hydration of NaCl. For NaCl-H₂O at 300°C, the combined OH stretch and HOH bend frequencies increase from 5229 to 5265 cm⁻¹, while salinity increases from 30 to 40wt%.

Lack of the garnet effect on zircon trace elements for TTG-like rocks

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To assess the garnet effect on uptaking of trace elements in TTG petrogenesis, *in situ* trace elements, U-Pb and Lu-Hf isotopes were analyzed for zircon from four rock suites of the TTG-like Huangling batholith at Yangtze Gorge in South China. The results indicate that the temperature is critical to HREE uptake in zircon. The Huanglingmiao suite have typical TTG composition, with higher La/Yb and Sr/Y ratios, lower Nb/La ratios, whole-rock ε_{Nd}(t) values and zircon ε_{Hf}(t) values than the other suites. For zircon from this suite, inherited cores and co-magmatic zones have indistinguishable trace element characteristics although their U-Pb ages and Lu-Hf isotopes differ significantly. All the zircons from the four suites are depleted in LREE, enriched in HREE with shallow MREE-HREE patterns, a positive Ce anomaly, and no Eu anomaly or very weak Eu anomaly. The last observation is in contrast to typical magmatic zircon, suggesting that feldspar was neither a stable phase during partial melting nor a removed phase during fractional crystallization. While LREE overabundance relative to whole-rock LREE is very common in the zircons from the granitoid suites, it is not so for zircons from the mafic dykes. The zircon from the TTG-like Huanglingmiao rocks have higher Hf, Y, Nb and Ta contents than those from other suites. However, Nb/Ta ratios for the all zircons from the Huangling batholith are similar to each other, with an average of 4.4. Most of the zircons have Ti concentrations lower than 30 ppm, yielding Ti-in-zircon temperatures of about 850°C.

The most important observation in this study is that no flat HREE patterns occur in the all zircons from the TTG-like Huangling batholith. In particular, neither the inherited cores nor the co-magmatic zones for the Huanglingmiao granitoids with typical TTG compositions show flat HREE patterns. This observation suggests that the garnet effect on the HREE uptake is quite limited even if garnet did exist as a residual phase during partial melting of the source materials of TTG rocks. Because partition coefficients of garnet/melt, zircon/melt and zircon/garnet in mafic to felsic rocks decrease with increasing temperature, relatively low temperatures of anatexis and crystallization may be a key to the HREE uptake in zircon from the TTG-like rocks.

Cambrian and Ordovician Oceanic Oscillations: New geochemical evidence from the Tarim Basin

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The Tarim Basin is a large endorheic basin located in the northwest China with a northern boundary of the Tianshan Mountain and a southern boundary of the Kunlun Mountain. This premier petroleum basin contains huge succession of Paleozoic, Mesozoic and Cenozoic sedimentary rocks ranging up to a thickness of locally exceeding 15 km in some regions. Previous studies have concluded that the major oil source rocks are from Cambrian-Ordovician. This current project was designed to better understand the paleoenvironment development of Paleozoic marine sediments, the potential source rocks of the huge natural gas. This paper is particularly focused on Earlier Paleozoic, namely Sinian-Cambrian-Ordovician succession. A deep drilling core recovered from the east part of the Tarim Basin, Well TD2 was finely sub-sampled for stable carbon and oxygen isotope analyses ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ of carbonate phases and TOC) and trace elemental measurements (ICP-MS). Our data shows that very strong fluctuations of geochemical parameters occur in the lower part of the core, i.e., from the Precambrian-Cambrian transition to Middle Ordovician sediments. Isotopic compositions of the carbonate phases vary in a very dynamic range, i.e., $\delta^{13}\text{C} = -10.1$ to $+3.2$ ‰ (STDEV = 3.19, VPDB) and $\delta^{18}\text{O} = -17.4$ to -5.1 ‰ (STDEV = 2.89, VPDB), respectively, showing at least seven depletion-enrichment 'cycles' during that ~100 Ma of time. Trace elemental compositions (Co, P, V, Zn etc.) and ratios (V/Ni) are significantly higher (~2-4 times) during those ^{13}C and ^{18}O depleted 'breaks'. The 'negative' correlation of stable isotope values and certain trace elemental concentration/ ratios led us to suggest that the cause of the multiple 'cycles' of isotopic depletion/ enrichment, in a rough pattern of about 10 Ma each cycle, could be due to strong episodic upwelling of oceanic waters. Our high resolution data suggests that at least seven major oceanic upwelling events occurred, leading to complete replacement of water bodies, thus causing large scale shifts of stable isotopic ratios of the carbonate rocks, marking the major transitions of geological units (formations) independent of lithologies basinwide.

The molecular level dissolution mechanisms of quartz under different pH conditions

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It is generally believed that the hydrolysis of Si-O-Si bonds is the key step in the dissolution processes of quartz-water system. High level *ab initio* molecular orbital calculations have been carried out to investigate the molecular level dissolution processes of the Q1(Si) site and Q2(Si) site of quartz at different pH conditions. Theoretical methods including potential energy surface calculation, transition states searching, reaction pathway optimization and *ab initio* molecular dynamics (ADMP) are used in this study. Our results show that under acidic condition, the protonation takes place at the terminal Si-OH unit but not at the bridging oxygen of Si-O-Si linkage. Such way of protonation results in stronger Si-O-Si bonding and makes the dissolution slightly slower than that at neutral condition. The rate-determining steps for both neutral and acidic conditions are the breaking process of Si-O-Si bonds. However, under base condition, rate-determining step for the dissolution of Q1(Si) site is the process of one water molecule approaching the Q1(Si) site. The activation energy results (at M05-2X/6-311+G(d,p) level) of transition states show that the dissolution rate will increase a lot at the base condition comparing with those at acidic or neutral conditions. Suggested by the activation energy results, the dissolution rate at acidic condition will be even slightly smaller than the dissolution rate at neutral condition. These findings are consistent with existing experimental evidences and correct a well-known previous theoretical model (Xiao and Lasaga, 1994) for the case of quartz dissolution.

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The bioleaching of low-grade chalcopyrite ore in the presence of activated carbon

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Chalcopyrite is the most important copper mineral. It is, however, relatively recalcitrant to chemical and bacterial oxidation because of its special crystal structure and electrochemistry in contrast to many other copper minerals. It is essential to find some desirable methods to enhance chalcopyrite bioleaching. The purpose of this work is to study the effect of activated carbon on bioleaching of low-grade chalcopyrite ore.

The low-grade chalcopyrite ore used in this study was obtained from Yongping Copper Mine, SE-China. The particle size was less than 5mm. The chemical composition is as follows: 0.40% Cu, 14.12% Fe, 13% S. The chemical phase analysis showed that chalcopyrite is 0.38% and the other copper minerals 0.02%. The mixed *Acidithiobacillus ferrooxidans* and *Acidithiobacillus thiooxidans* used in this study were isolated from acid mine drainage at Yongping Copper Mine. Leaching experiments were carried out in 250 mL elenmyer flasks with 80ml 9K + S medium without Fe²⁺ and 20ml inoculation at initial pH 1.20 (pH values were controlled within 1.50 during the bioleaching) and 25%(W/V) pulp density. The flasks were incubated in a rotary shaker at 130 rpm and 30°C.

The activated carbon can greatly enhance the copper dissolution during the bioleaching of low-grade chalcopyrite ore. The solution with a concentration of 3.0 g /L activated carbon is most beneficial to the dissolution of copper, whose recovery is increased from 11% to 79% after 600 hour bioleaching, being 68% higher in the presence of activated carbon than that in the absence of activated carbon. The enhanced copper dissolution can be attributed to the galvanic interaction between activated carbon and chalcopyrite. The lower redox potentials are more favorable to the copper dissolution than the higher redox potentials for low-grade chalcopyrite ore in the presence of activated carbon.

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Paleogeothermal field in Dongsheng area, Ordos Basin

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Background

Geothermal gradient was low in Paleozoic and Early Mesozoic in Dongsheng area, Yimeng uplift resulting in a low level of thermal evolution of source rocks, and it increased up to 3.3□/100m in Late Mesozoic. The Late Mesozoic tectonic thermal events and the later continuous uplifting in Dongsheng area would have resulted in the active movement of thermal fluid [1]. The paleogeothermal field in Dongsheng area, NW-China, is discussed based on vitrinite data in the paper.

Palaeogeothermal Simulation Parameters

The main parameters used in the simulation are lithologic, stratigraphic geological parameters and vitrinite reflectance. The lithological parameters come from the average values of the corresponding parts of the measured data of the basin, and the stratigraphic geological parameters are selected from Drill ZKB19-72.

Calculation of Denudation Thickness

The homogeneous temperature of mineral inclusions taken from sandstone of the Zhiluo Formation in the area ranges from 75.6°C to 148.9°C, an average is 116.9°C. By the relationship between geotemperature and burial depth. The denudation thickness is identified as 900m to 1200m.

Stratigraphic Burial History

The model for Windows 2004 [2] is applied to simulate the erosion depth and the buried history of strata in the area by different simulators. The simulation results show that the strata formation had been in sedimentation from 160ma ago to 130Ma ago, in standstill stage from 130ma ago to 105Ma ago, and has been in rising since 105Ma ago. In this inversion simulation, the thickness of stratigraphic erosion of the basin is relatively small, around 1100m.

Geothermal History

The reconstruction of geothermal history [3] of Ore-bearing strata indicates that the strata suffered the maximum temperature of 86°C and the geothermal gradient of 51 °C/km.

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Kinetic experiments of basalt and feric minerals reacted with water at high temperatures above 300°C

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Kinetics of basalt and feric minerals reacted with water and NaCl-H₂O at high temperatures (T) plays an important role in hydrothermal processes at MOR. Steady-state dissolution rates of olivine, pyroxene, actinolite and basalts have been measured at T from 25 to 400°C at 23-35MPa. The mineral samples used in these experiments have been analyzed chemically. Their compositions and structure are also analyzed through SEM and TEM before and after reactions. All dissolution experiments were carried out in mixed-flow reactor or packed bed reactor (with Zr metal liner), and performed at far-from-equilibrium conditions. The dissolution of the minerals in water, such as olivine, pyroxene, actinolite, may require the breaking of more than one metal-oxygen bond type. Different metal elements in minerals behave different release rates, so that the dissolution product is often not stoichiometric. Experiments found that Na, Mg, Fe, Ca dissolve usually faster than Si at T < 300°C, 23 MPa. In contrast, at T ≥ 300°C, Si release rate is higher than other metals. For both feric minerals and basalt, the maximum release rates of Si are often present at 300°C, 23 MPa. For diopside, Ca /Si (or Mg/Si) release ratio at T near 200°C is stoichiometric. The no-stoichiometric surface layer was found by analyzing of SEM and TEM. At T < 300°C, surfaces of feric minerals after reacted with water is a light Si-rich and little Fe (or/and Mg, Ca) deficient. In contrast, at T ≥ 300°C, the surfaces reacted with water is a light Fe-rich and little Si deficient. TEM study indicates that amorphous surface layer was found. Metal-H⁺ exchange and hydration reaction on mineral surface will pass through this layer. Results prove that Fe-oxide precipitates at T from 300 to 400°C in near neutral solutions at MOR.

Late Cenozoic episodic uplifting in southeastern part of the Tibetan plateau — Evidence from Ar-Ar thermochronology

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The Xianshuihe fault zone, located in southeastern part of the Tibetan plateau, is a huge and active sinistral strike-slip fault zone. This fault zone is an important seismic fault in east Tibet. Earthquake geology studies and offset patterns of young geological features have shown that late Quaternary sinistral slip rate of the Xianshuihe fault zone reaches 13 mm/a. Field survey and structural measurements show two different shear deformation zones of the Xianshuihe fault: a brittle-ductile shear zone to the west and a ductile mylonite shear zone to the east. This latter is in transition with undeformed granites. Isotope chronological study on this fault zone can provide age evidence on the mass transport and uplifting history in southeastern part of the Tibetan plateau.

Ar-Ar thermochronological study show that during the late Cenozoic sustained sinistral strike-slipping of the Xianshuihe fault zone, the differential uplifting occurred in different part of the Fault zone. Comparing with the Ar isotope system closure temperature of biotite, the time of uplifting and cooling through 350°C in the westnorthern part, the middle part and the eastsouthern part of the Xianshuihe fault zone is 10.39Ma-10.13Ma, 5.70Ma-4.42Ma and 3.60Ma-3.46Ma respectively. This result prove that southeastern part of the Tibetan plateau has experienced episodic uplifting since late Cenozoic and the episodic uplifting time is ~10.1Ma, 5.7Ma-4.4Ma and ~3.6Ma respectively.

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Sources and fate of nitrate and sulfate in a sandy aquifer: A multi-isotope study

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Nitrate and sulfate are common pollutants in groundwater in areas with intensive agriculture. In this study, we combine multi-isotope analyses ($\delta^{34}\text{S-SO}_4$, $\delta^{18}\text{O-SO}_4$, $\delta^{15}\text{N-NO}_3$, $\delta^{18}\text{O-NO}_3$) with geochemical analyses and groundwater age dating ($^3\text{H}/^3\text{He}$) to identify the sources, sinks and the relevant transformation processes of nitrate and sulfate in a sandy aquifer at Oostrum, the Netherlands. We specifically focus on the role of denitrification coupled to pyrite oxidation and compare results for sites in cultivated land to a site in an adjacent forested area.

The groundwater in our study area is characterized by extremely high nitrate and sulfate concentrations, with maximum concentrations of 8 mM (500 mg/L) and 4 mM (400 mg/L), respectively. The isotope composition of groundwater from shallow depths (<10 m) at cultivated and forested sites is, in general and regardless of age, rather similar, suggesting mostly common sources of nitrate and sulfate. Only at the forest site, a slightly higher atmospheric deposition is inferred from both $\delta^{18}\text{O-SO}_4$ and $\delta^{18}\text{O-NO}_3$ values. Sulfate concentrations increase and nitrate concentrations decrease in groundwater in a “reaction zone” between 10 and 20 m depth in groundwater in cultivated areas. The changes in isotopic composition of the groundwater in this reaction zone confirm geochemical analyses suggesting that denitrification is coupled to pyrite oxidation in this aquifer [1]. Isotope analyses of groundwater from the deeper part of the aquifer (> ~25m) indicate sulfate removal through microbial sulfate reduction.

[1] Zhang *et al.* (2008) *GCA* **72**, A1090.

Global-through-urban WRF/Chem: A unified model for modeling aerosol-climate interactions

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Introduction

Simulating aerosol-climate interactions presents a major challenge in quantifying the impacts of air pollution on climate change. A unified Global-through-Urban Weather Research and Forecasting Model with Chemistry (GU-WRF/Chem) is being developed at North Carolina State University to accurately simulate feedbacks among meteorology, chemistry, aerosols, clouds, and radiation at all scales. This study highlights recent model developments and application over nested domains from global to urban scales.

Model Development and Application

The main model developments include the incorporation of the U.S. EPA's 2005 Carbon Bond Mechanism (CB05) using the Kinetic PreProcessor (KPP), the extension of CB05 to simulate halogen and mercury chemistry and stratospheric chemistry involving greenhouse gases, and heterogeneous reactions for global applications (referred to as CB05 for global extension (CB05GE)), the coupling of CB05GE with the Model of Aerosol Dynamics, Reaction, Ionization, and Dissolution (MADRID) and aqueous-phase chemistry, and the incorporation of an aerosol activation module to simulate indirect aerosol effects via serving as cloud condensation nuclei (CCN) and affecting cloud droplet number concentration (CDNC). Nested simulations are being conducted for 2001 over multiple domains such as a global domain at 4° (Lat) \times 5° (Lon), a Trans-Pacific domain covering Asia, Pacific, and North America at $1.0^\circ \times 1.25^\circ$, the continental U.S. and China at $0.33^\circ \times 0.42^\circ$, and the eastern U.S. at $0.11^\circ \times 0.14^\circ$. Model evaluation using surface and satellite data is being conducted to assess the model capability in reproducing meteorological and chemical observations. The feedbacks of aerosols to simulated meteorology, radiation, and CCN and CDNC as well as associated seasonalities are being examined. Major challenges in simulating aerosol-climate interactions will be discussed.

The distribution and geochemical characteristics of biogenetic gas in China

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The biogenetic gases are mainly distributed in Qaidam basin, Songliao basin, Bohai Bay basin, Ying-Qiong basin, some small basins of Yunnan province and eastern coastal region in China. Most of the biogenetic gases are accumulated in Quaternary, Tertiary and Cretaceous. The distribution formations of the biogenetic gases are distinguished in different area. The burial depth of biogenic gas reservoir is generally less than 1900m with the shallowest reservoir is only about ten meters.

The main component of biogenetic gas is methane which is usually more than 85%. Some heavy hydrocarbons such as ethane and propane can be detected in some samples. The distribution of carbon isotopic value of methane is from -89.4‰ to -55.1‰, mainly distributing from -75‰ to -55‰. The carbon isotopic sequence is positive, $\delta^{13}\text{C}_1 < \delta^{13}\text{C}_2 < \delta^{13}\text{C}_3$. The carbon isotopic value of CO_2 is mainly from -25‰ to -5‰. The hydrogen isotopic value of methane main is from -277‰ to -200‰.

The resources of biogenetic gas in many Mesozoic and Cenozoic basin are abundant in China. Paying more attention to the Qaidam basin, Songliao basin and Bohai Bay basin was suggested for the afterwards biogenetic gas exploration activities.

Degassing of lunar basalts

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Lunar basalts are often vesicular with mm-size bubbles. This report investigates bubble growth in lunar basalts. Using conditions relevant to lunar basalts, bubble growth is calculated using the program of Proussevitch and Sahagian [1] with slight modification [2] and compared with bubble growth in terrestrial melts. First, the accuracy of the bubble growth program is verified using rhyolitic melt for which extensive data are available. Experimental bubble growth data in rhyolite [2] are compared with program calculations using models of H_2O solubility [3] and diffusivity [4] and melt viscosity [5]. The comparison verifies that as long as solubility, diffusivity and viscosity are known well, bubble growth rates can be calculated fairly well (often within 20% relative). To treat bubble growth in lunar basalts, initial H_2O content of 700 ppm [6] is used and the effect of other volatiles is ignored. Because lunar atmospheric pressure is essentially zero, the confining pressure on bubbles is supplied by overlying magma. Due to low H_2O content in lunar basaltic melt (corresponding to a saturation pressure of 75 kPa), H_2O bubbles only grow in the upper 16 m of a basalt flow or lake. A depth of 20 mm corresponds to a confining pressure of 100 Pa; and a depth of 1 m corresponds to pressure of 5 kPa. In the modeling, H_2O solubility at low pressures [7], diffusivity in basalt [8], and lunar basalt viscosity [9] are used. Some findings are as follows. (a) Because pertinent pressures are low, bubble pressure due to surface tension plays a main role in lunar bubble growth, contrary to terrestrial bubble growth. (b) Bubble growth is very rapid; at 1523 K mm-size bubbles can be formed in time scale of seconds or less for confining pressure of 5 kPa or less. (c) Time scale to reach equilibrium bubble size increases as the confining pressure increases. The presence of other volatile components will complicate the modeling.

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Mineralization mechanism and geodynamic setting of No.337 uranium deposit, South China

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Xiazhuang uranium ore-field was one of the most important granite-type uranium deposits in China. No.337 deposit has been taken as a representative of the earliest (138Ma), relatively high temperature (300°C) and short time gap between the formation of host-granite (142Ma of Rb-Sr isochrone) and the mineralization in Xiazhuang uranium ore-field since late 1980's.

But latest study revealed that the formation age of the Maofeng pluton, the most important host granite of this deposit, is 238.2~206Ma by LA-ICP-MS zircon dating, while the secondary muscovite in Maofeng pluto yields the age of 131~136Ma by $^{40}\text{Ar}/^{39}\text{Ar}$ dating which corresponding to the main mineralization age of 130.3~138Ma in No.337 deposit. Further study undeveloped that in Guidong granitic complex Maofeng pluto shown some distinct characteristics. It has the $\text{Al}_2\text{O}_3/\text{TiO}_2$ ratio that inferred the lowest forming temperature. It has the lowest ΣREE and was the only pluto which presents typical tetrad effects of REE in Guidong granitic complex. It is also shown a varying $\delta^{18}\text{O}$ values and the lowest ($^{87}\text{Sr}/^{86}\text{Sr}$)_i values. The above founding on dating and geochemical characteristics revealed that Maofeng pluto had been underwent an intensive alteration during the stage of 130~140Ma.

Combining this new finding with the geodynamic setting of this area, a concept model of uranium mineralization and geodynamic setting for No.337 uranium deposit might be presented: in late or post-collision stage of Indosinian Orogeny, strongly peraluminous granite of Maofeng pluto formed from partial melting of uranium rich formations. Intrusion of mafic in late Yanshanian Period (<140 Ma) caused large fluid movement. Uranium was reactivated and extracted from the altered granite, and then precipitated in some favorite places to form uranium ore bodies. No.337 uranium deposit was a typical represent of the first stage uranium mineralization in Xiazhuang uranium orefield.

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Inapplicability of TEX_{86} index as temperature proxy in stratified lakes

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The application of TEX_{86} index to reconstruct paleotemperature from lake sediments has so far been limited to a few large lakes using an ocean sediment-derived paleotemperature equation. The applicability of the index to sediments in small lakes remains a question. We have collected surface sediments from a variety of lakes extending from the Arctic to southern Patagonia; no clear linear regression between TEX_{86} and mean annual temperature could be established. The large annual temperature range in mid to high latitude lakes distinguishes them from typical ocean conditions. We studied the GDGTs-based index distribution in the water column in a stratified lake in Lofoten region, NW Norway. We measured the physical parameters of the lake (temperature, salinity, pH, etc) and filtered water at different depths to determine how the modern distributions of GDGTs and TEX_{86} indices correspond to conditions in the water column. Results indicate that TEX_{86} indices and temperatures in the water column *in situ* are not correlated. The oxycline started above the thermocline but their bases are the same depth. The abundance of the isoprenoid GDGTs starts to increase rapidly at the beginning of the oxycline rather than the thermocline, and reaches the maximum (30 times more abundant than at the surface) at the base of the oxycline. Isoprenoid GDGTs then have similar abundance in the anoxic zone as at the top of the oxycline, indicating that methanogenic archaea rather than thermophilic archaea made the most significant contribution to isoprenoid GDGTs in the sediments of this stratified lake. The TEX_{86} indices are higher in the oxycline and anoxic zone than in the surface. The stream water in the catchment also carries the suite of GDGTs in the TEX_{86} equation. The peat in the lake catchment also contains some of the isoprenoid GDGTs, further complicating the signal of TEX_{86} in the sediment.

Fluid geochemistry of Dabate porphyry copper deposit, western Tianshan in Xinjiang, NW China

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Dabate Cu deposit is a new discovery in western Tianshan. The results of analyses on homogeneous temperature and salinities analyses on the fluid inclusions and H and O isotopic composition show that in different quartz samples, each type of fluid inclusions has similar homogeneous temperature, salinities and density. Oxygen and hydrogen isotope studies show that the ore-forming fluids are mainly from magma and probably deep-derived or mantle-derived. The ore-forming fluid display low salinity with the values mainly range from 2.9% to 7.2%. The homogeneous temperature of the gas and liquid phase range from 185 to 390°C and most value between 185 to 283°C. The melted temperature of inclusions with daughter minerals is between 181 to 431°C.

Combining the Re-Os and U-Pb dating, we suggest that the tectonic event occurred during late Carboniferous to early Permian, resulted emplacement of deep-derived porphyry magma and formed volcanic apparatus which consist of granite-porphyry, rhyolitic porphyry and rhyolitic crystal tuff lava. Considering the special relationship between the ore bodies and volcanic and sub-volcanic rocks, combining the geological information from isotope and fluid inclusion studies, the authors concluded that the ore-forming fluids are deep-derived but the ores are deposited at medium to hypabyssal environment. The Cu(Mo) mineralization is closely related to the late phase of the volcanic apparatus.

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Fluid inclusion characteristics of Dachang gold deposit in Eastern Kunlun orogenic belt, Western China

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Using advanced Linkam cooling-heating stage and Renishaw Laser Raman Spectrometer, the authors carried out systematic studies on the primary fluid inclusions in quartz and calcite from the Dachang gold deposit in Qinghai Province. The results show that quartz and calcite contain lots of primary fluid inclusions, which can be classified into aqueous two-phase type, CO₂-bearing three-phase type and CO₂-rich or pure CO₂ type. Microthermometric studies indicate that the temperatures, salinities $w(\text{NaCl}_{\text{eq}})$ and densities of the ore-forming solutions vary from 180 to 260°C, 0.2% to 8.3%, and 0.69 to 0.78 g/cm³, respectively. The ore-forming fluids belong to the NaCl-H₂O-CO₂ type characterized by rich CO₂, low-moderate temperature, low salinity, low density and strong reducibility. Meanwhile, the data of ore-forming pressure were also obtained from the fluid inclusion study. Based on the pressure and the relationship between the pressure and the depth of fracture zones, it is known that the ore-forming depth is 5.03-7.63 km. The ore-forming fluids are mainly composed of H₂O and CO₂, with minor amounts of CH₄, H₂S, CO, N₂, H₂ and trace amounts of such organic matters as C₂H₂, C₂H₄, C₂H₆, C₃H₈ and C₆H₆. The ore-forming fluids of the Dachang gold deposit were mainly derived from meteoric water mixed with formation water and a small amount of mantle-source magmatic water. Fluid immiscibility and existence of organic matters play important roles in the gold mineralization process.

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Geochemistry of the Xiong'er volcanic rocks: Implications for the Paleoproterozoic accretion of the North China Craton

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The Xiong'er volcanic belt along the southern margin of the North China Craton is dominated by basaltic andesite and andesite with minor dacite and rhyolite. Geochemically, the Xiong'er volcanic rocks fall in the calc-alkaline series, with enrichments in the LILE and LREE, and negative anomalies on Nb-Ta-Ti, similar to arc-related volcanic rocks (He *et al.* 2008; Zhao *et al.* 2009). Available SHRIMP and LA-ICP-MS U-Pb zircon age data indicate that the volcanism forming the Xiong'er volcanic rocks erupted intermittently over a protracted interval from 1.78 Ga, through 1.76-1.75 Ga and 1.65 Ga, to 1.45 Ga, though a major phase of the volcanism occurred at 1.78-1.75 Ga (He *et al.* 2009). Taken together, the Xiong'er volcanic belt was most likely a Paleoproterozoic continental magmatic arc at the southern margin of the North China Craton. Age-similar continental magmatic arcs were also present at the southeastern margin of Laurentia, southern margin of Baltica, northwestern margin of Amazonia, and southern and eastern margins of the North Australia Craton, which are considered to represent subduction-related outbuilding on the continental margins of the supercontinent Columbia (Zhao *et al.* 2004).

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Genesis of gold deposits in the Xiaoqinling district, southern margin of the North China Craton

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The Xiaoqinling gold district is the second largest gold producing center in China and is located in a basement-cored uplift along the southern margin of the North China Craton. The ore is hosted mainly by quartz veins and subordinately by adjacent alteration zones within Archean amphibolite-facies basement rocks. The mineralised veins consist, apart from quartz, of carbonates, pyrite, galena, chalcopyrite, sphalerite and locally molybdenite (*e.g.* Dahu Au-Mo deposit). Gold occurs predominately in textural association with pyrite. Wall rock alteration encompasses pyrite, quartz, sericite, carbonates, epidote, chlorite and K-feldspar.

In view of a Au-Mo association at some localities and the presence of two late Yanshanian (~140 Ma) granite plutons, a genetic link with this magmatism may be possible. The Au deposits are, however, 2 to 10 km away from these granite bodies and bear otherwise typical characteristics of orogenic gold (low salinity, CO₂-rich ore fluids; spatial association with large-scale compressional structures of the Qinling orogen; $\delta^{18}\text{O}$ and δD data suggestive of mixing between metamorphic and meteoric waters; $\delta^{34}\text{S}$ and Pb isotopic data that point to a mixed crustal-mantle source) as shown in previous studies.

Re-Os dating of molybdenite from the Dahu gold deposit yielded Indosinian model ages of 223 - 232 Ma [1] and an isochron age of 218 ± 41 Ma [2], which are suggested to date the main stage of gold mineralization.

We propose that mineralization was a consequence of subduction during Indosinian collision between the North China Craton and the Yangtze Craton. Metamorphic devolatilization of the subducted slab would have provided the main source of the ore fluids. In places, some remobilisation of the ores may take place during Yanshanian crustal thinning, but more work, in particular field relation and precise age dating, are needed.

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The characteristics of mantle peridotite xenoliths in the Cenozoic volcanic rocks from southeastern China and implication for deep processes in the upper mantle

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There are lots of differences in petrology, mineralogy, trace elements and Sr-Nd isotopic composition among peridotite xenoliths from the Cenozoic basalts in the Southeast China. The peridotite xenoliths in volcanic rocks (34.3±1.0Ma) [1] from Puning and those in volcanic rocks (2.2~0.9Ma) [2] from Mingxi are similar to the Kaapvaal Archean peridotite and to the abyssal peridotite, respectively, in content of orthopyroxene.

The characteristics of petrology, trace elements and Sr-Nd isotopic composition of the peridotite xenoliths in Puning provide evidences that the formerly depleted peridotite had probably been metasomatized by H₂O-bearing and SiO₂-rich fluids, produced by the subduction of oceanic plate[3]. Continental lithospheric mantle predating 34.3±1.0Ma may have undergone an enrichment process caused by the subduction in the Mesozoic. Thus the continental lithospheric mantle has the characteristics of both Archean lithospheric mantle and the mantle influenced by Pacific Oceanic plate subduction, implying the interaction between the oceanic lithosphere and the continental lithospheric mantle.

The peridotite xenoliths from Mingxi are enriched in LREE but more depleted in Sr-Nd isotopic composition. So the peridotite xenoliths in the Mingxi volcanic rocks may represent the lithospheric mantle influenced by the asthenospheric upwelling, that is, the lithospheric mantle might be reacted by SiO₂-poor fluids from deep mantle. It is therefore suggested that there was an interaction between the mantle peridotites and fluids related to the asthenospheric upwelling.

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Difference evolution of the clay minerals of the three Paleogene depressions in Bohai Bay Basin, China, and its conditionality

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The authors collected samples systematically from different depths of the strata in the Jiyang Depression, the Changwei Depression and the Damintun Depression, which belong to Bohai Bay Basin. The phase and the chemical composition of the extracted clay minerals(<2µm) from the samples were analyzed on the X-ray Diffraction Machine and the Electronic Probe Instrument. The study results are as follows: (1) During the Paleogene, the buried depth was the largest in the Jiyang Depression, which produced the best evolution of the clay minerals. The buried depth of the Damintun Depression was the smallest, which produced the weakest evolution of the clay minerals. The buried depth and the evolution extent of the clay minerals in the Changwei Depression were both between those of the other two. (2) With the clay mineral geothermometry, the paleogeothermal gradients of the Paleogene depressions were calculated. The average paleogeothermal gradients were 38.3°C/km, 39°C/km, and 35°C/km in the Jiyang Depression, the Changwei Depression and the Damintun Depression, respectively. (3) Analysis of the regional geology shows the sedimentation rates in the Jiyang Depression and the Changwei Depression during the Paleogene were larger than that in the Damintun Depression. So the Paleogene strata in the Jiyang Depression and the Changwei Depression were obviously thicker than that in the Damintun Depression. Caused by the subsequent action of the dextral shear stress to the Jiyang Depression, the buried depth in the area was increased. But this shear stress had less influence to the Changwei Depression. Therefore, the difference evolution of the clay minerals related to the structural actions and the sedimentation rates in Bohai Bay Basin.

Geochemical and Nd-Hf isotopic constrains on the origin of the ~1.74 Ga Damiao anorthosite complex, North China Craton

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The ~1.74 Ga Damiao complex in the North China Craton consists of anorthosite (85 volume%) norite (10 volume%) mangerite (4 volume%) accompanied by minor troctolite and noritic, gabbroic and ferrodioritic dykes [1,2,3]. The complex hosts abundant Fe-Ti-P-V ores and has an emplacement sequence from anorthosite, norite, Fe-Ti-P deposit to mangerite. Anorthosites and norites are mainly composed of antiperthite ($An_{44}Ab_{50}Or_6$) and high-Al orthopyroxene megacrysts indicative of their polybaric crystallization. Their variable major and trace elemental compositions suggest that these rocks are the mixtures of cumulus minerals with trapped liquids.

The diverse components of the Damiao complex have similar REE patterns and Nd-Hf isotopic compositions with $\epsilon_{Nd}(t)$ values mostly within -5.0 to -4.0. Average $\epsilon_{Hf}(t)$ values of zircon are -4.7 for mangerite and -5.9 for norite, suggesting that they formed from a common parental magma by continuous fractionation. The occurrences of plagioclase and high-Al orthopyroxene megacrysts, together with the high calculated Sr contents (407-722 ppm), indicate that their parents would be high-Al gabbroic. Such high-Al gabbroic magma most likely originated from a lower crust source, as suggested by their high La/Nb (mostly >1.5) and Zr/Nb (10.2-40.2) but low La/Yb (<10) ratios. This interpretation is also supported by the zircon $\epsilon_{Hf}(t)$ and whole-rock $\epsilon_{Nd}(t)$ values that plot close to the evolution lines of the ~2.5 Ga Archean rocks in the North China Craton. High-degree melting (>75%) of the lower crustal rocks require high temperatures when forming the parental high-Al gabbroic magma. Such scenario can be compatible with the widely accepted major orogeny that occurred at ~1.85 Ga in the North China Craton. This collision may have resulted in downthrusting of crustal rocks into the upper mantle where ambient high temperatures were able to melt the thrust crust tongue directly to form an initial deep-seated magma chamber [4] during post-collisional extension at ~1.74 Ga.

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Deformation and component migration during mylonitization in ductile shear zones, south Tan-Lu fault belt

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Introduction

Because mylonites record special phenomena in the geological process of crustal deformation, geologists have paid great attention to them from various aspects. There are a series of ductile shear zones developed in slide formation of south Tan-Lu fault belt [2]. The relationship between metamorphism and deformation in ductile shear zones, south Tan-Lu fault has been extensively studied by Yang *et al.* [1,3]. This study mainly pays attention to the relationship between the volume loss, fluid flow and component variations in different ductile shear zones in south Tan-Lu fault belt, trying to illustrate the elemental migration mechanism during crustal deformation.

Results

The mylonites are enriched by factors of 1.50 or so in elements of TiO₂, P₂O₅, MnO, Y, Zr and V and depleted in SiO₂, Na₂O, K₂O, Al₂O₃, Sr, Rb, U, Ba and light REEs compared to their protolith gneiss. The immobile element enrichments are attributed to enrichments in residual phases such as ilmenite, zircon, apatite and epidote in mylonites and are interpreted as due to volume losses from 10% to 55% in different ductile shear zones. The largest amount of SiO₂ loss is 37g/100g in the ductile shear zone, which shows the fluid infiltration. Modeling calculated results of the fluid/rock ratio for these ductile shear zones range from 200 to 1200 by assuming different degrees of fluid saturation.

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Plastic deformation enhanced diffusion mass transfer and metamorphic transformation in shear zones developed in deep continental subduction channel

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The effect of deformation on metamorphism and that of metamorphic reaction on strain softening and localization in shear zones in crust are well documented. But the interplay of the two processes in deep continent subduction channel is poorly explored. Understanding of the interaction of the two in the subduction regime is essential for understanding deformation behavior and HP-UHP metamorphism of continental crusts in deep subduction zones. Study of rocks from an undeformed pyroxene-bearing granite block and strain-localized shear zones in the block in an HP-UHP ductile shear complex at Yangkou, Sulu UHP metamorphic belt, China reveals that the undeformed granite has preserved granitic texture and primary mineral assemblage of hypersthene, augite, plagioclase, K-feldspar, quartz and biotite. UHP metamorphic transformation is limited to coronas, 10-20 microns wide at grain boundaries between plagioclase, hypersthene and biotite. In mylonite from the shear zones most of the primary minerals are sheared into thin mono- or poly-mineralic bands that are transformed to UHP phases except augite that stands as porphyroclasts in a mylonitic matrix. Hypersthene and biotite disappear instead fine grained omphacite, garnet and garnet-rutile bands occur. Plagioclase is transformed into poly-mineralic bands composed of fine-grained garnet, kyanite, zoisite and albite (retrograd). Augite porphyroclasts often have pressure shadows with rutile precipitation. Deformation conditions estimated using the syn-deformation phases, garnet-omphacite-kyanite-phengite-quartz/coesite, are ca 550-600°C and a minimum pressure 2.5 GPa. This study suggests that metamorphic phase transformation in the undeformed granite is slow and limited to grain boundaries due to lack of fluid activity and slow diffusion rate within and between minerals. In the shear zones dynamic recrystallization-accommodated dislocation creep results in significant grain size reduction of the primary minerals, which increases reaction surface area and enhanced metamorphic transformation. Fluid released by biotite leads to diffusion mass transfer that greatly accelerates the metamorphic process.

Chemical architecture of the Dabie orogen: constraints from zircon Hf and whole-rock Sr-Nd isotopes in Mesozoic magmatic rocks

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Zircon Hf and whole-rock Sr-Nd isotope compositions were determined for Mesozoic mafic-felsic intrusions in the Dabie orogen, east-central China. The results provide not only insights into their petrogeneses, but also constraints on chemical architecture of the continental collision orogen prior to the Early Cretaceous magmatism. Zircon Hf isotope analyses show negative $\epsilon_{\text{Hf}}(t)$ values of -26.3 ± 0.6 to -7.0 ± 0.5 for pyroxenite and gabbro, with Hf model ages of 1097 ± 19 Ma and 1749 ± 20 to 1837 ± 22 Ma relative to the depleted mantle. Granitoids also have negative $\epsilon_{\text{Hf}}(t)$ values of -31.6 ± 0.5 to -16.9 ± 0.9 , with crust Hf model ages of 2251 ± 55 to 3162 ± 28 Ma. Both the mafic and felsic magmatic rocks have high initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of 0.7065 to 0.7084 and very low $\epsilon_{\text{Nd}}(t)$ values of -21.7 to -11.7 . The zircon Hf model ages of the pyroxenite and gabbro are respectively consistent with two major events of crust-mantle differentiation at late Mesoproterozoic (~ 1.16 Ga) and middle Paleoproterozoic (~ 1.92 Ga) as recorded in zircon Hf isotopes of the Dabie UHP metaigneous rocks. This suggests that remelting of subcontinental lithospheric mantle formed at the two episodes is responsible for the Mesozoic mafic rocks. The granitoids have the crust Hf model ages as old as 3.16 Ga, which cannot be only formed by reworking of the Dabie UHP metaigneous rocks, but requires involvement of ancient Archean crust. Thus, there may source mixing in which one endmember resembles the North Dabie gneiss with middle Paleoproterozoic Hf model ages (~ 1.9 Ga) and the other endmember is like the Kongling gneiss with Archean Hf model ages (~ 3.5 Ga). Therefore, the Mesozoic magmatic rocks in the Dabie orogen were formed by remelting of subducted continental lithosphere in the northern edge of the South China Block. Combined the present and previous studies, the Dabie orogen would have a three-layer crustal structure prior to the Early Cretaceous magmatism: Central Dabie in the upper with dominantly young Hf model ages of late Mesoproterozoic (~ 1.16 Ga), North Dabie in the middle with dominantly Hf model ages of middle Paleoproterozoic (~ 1.92 Ga), and the source region of the Early Cretaceous magmas in the lower with both middle Paleoproterozoic (~ 1.92 Ga) and Archean (~ 3.5 Ga) Hf model ages.

Geochemical conditions of the groundwater for developing bursting pingos in Jingxian valley, Tibetan Plateau

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In order to classifying the grade of geological hazards in the permafrost field □ Tibetan Plateau, we have investigated 46 field points and collected data of 168 points. Bursting pingos in Jingxian valley, between active fault F6 and F7, is one relative large pingos among bursting pingos group trending in SW50°, which is 60m west away from Qinghai-Tibet Highway, with geographic location of LONG. 94°02'57" and Lat. 35°40'09". In the early of 1980th, six hydrogeologic drillings had finished along WWS direction in the Jingxian valley. The Kurllov's Formula of water samples is [1],

$$M_{3.0-1.5} \frac{HCO_3^{64-13} Cl_{85-31}}{Na_{89-96}} T_{0.1}$$

HCO₃⁻ is obviously decreasing from northeast to westsouth, and the content is from 64 to 46 to 52 to 32 to 14(meq) in turn.

The groundwater took place deoxygenation and reduction action to produce some gas as CO₂ etc. Salt-alkali lacustrine facies aquifer with humus has weak permeability. More and more aqueous gas gathered in part space and pressure increased, which may induce perdu sub-fault activity and cause press up from depth. During melting period of frozen soil, burst took place when pressure undertook by pingos was far less than inside swelling force.

The investigation and study indicates that the subpermafrost enriched in carbon and oxygen was crucial factor for the forming of bursting pingo at Jingxian valley, and the high salt-alkalinity of water-bearing strata was essential condition for gathering aqueous gas mixture pressure of pingos, and secondary deep fractures of active faults were the important sources of compensation pressure.

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Impact of redox gradient on fault gouge formation related to fracture activities along the Ushikubi fault zone in Central Japan

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The fault gouge samples, collected from two sites along the ENE-WSW trending Ushikubi fault zone in central Japan, have distinguishable variations in their physical properties such as surface colors and structure. These features are also reflected by the mineralogical and chemical compositions, particularly iron and sulfur speciation, which were determined using X-ray diffraction, X-ray fluorescence spectrometer, X-ray near edge structure, and ⁵⁷Fe Mössbauer spectroscopy, respectively. Chemical species of iron and sulfur, and mineral compositions indicate redox change within the fault fractures in relation to the gouge formation of fault gouge and fault features, especially the active state of the fault. Newly formed minerals, including calcite, dolomite, siderite, iron sulfide and pyrite, have close relation to the colors of fault gouge and respective to the geochemical environment within fault zone. In addition, such mineralogical and chemical variations may have significance to evaluate the activity of faults. These fault gouge samples in yellowish color occurred in site one, and no clear difference in chemical and mineral compositions among the three samples from a relatively older rupture zone indicating a long history of the fracture and also a stable state and being suitable to fault gouge formation. However, there is clear enrichment of reducing species of iron and sulfur as well as chlorite in the site two, a relatively younger fracture, indicating favorable connection pathway with deep position and the fault zone is active. These results from mineralogical and chemical analyses have a good agreement with evidence indicated by ¹⁴C dating from this fault zone.

Sources, distributions and transport processes of Pu isotopes in the NW Pacific margin

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Plutonium was introduced into the environment mainly from the fallout of atmospheric nuclear weapons tests. Over the past years, we have made a systematic investigation on the distribution of Pu isotopes in the NW Pacific Ocean and its adjacent seas: the East China Sea, Okinawa Trough, the Japan Sea and the Okhotsk Sea. Based on the obtained $^{240}\text{Pu}/^{239}\text{Pu}$ ratio signature, we identified the wide presence of Bikini close-in fallout Pu in the studied regions, which contributed to the excess Pu inventories. We proposed that the oceanic process is responsible for the wide presence of Bikini close-in fallout Pu. Using a two fallout end-member model, we resolved the relative contribution of Pu between global fallout and close-in fallout in sediments. We concluded that the contribution of Bikini close-in fallout Pu ranged from 10 % to 60 % in the studied regions [1-5].

To verify our hypothesis on the oceanic process for the transport of Pu in the Pacific Ocean, we further investigated the Pu isotopic signature in seawater and settling particles in the western Northwest Pacific [6-7]. Three transport processes were identified to be responsible for the distribution and fate of Pu isotopes in the NW Pacific margin: (1) advective lateral transport of dissolved Pu from open ocean to ocean margin; (2) vertical transport of Pu isotopes via particle scavenging; and (3) the bottom layer lateral transport and redistribution of Pu isotopes.

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Determination of lead isotopes ratio in rock samples by ICP-MS

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Lead has four nature isotopes: ^{204}Pb , ^{206}Pb , ^{207}Pb , ^{208}Pb . Generally, it is treated as a steady reference isotope. ^{206}Pb , ^{207}Pb , ^{208}Pb is the descendant of ^{238}U , ^{235}U and ^{232}Th . Its abundance is continuously changing. Through the geochemistry research of lead isotope, the mineralogical epoch or pattern age could be confirmed. The origin of metallogenic substance and mineral deposit could also be judged.

Conventional method for measuring lead isotope is using the ion exchange technique to separate and gather lead, then test the lead isotope by the TIMS. Using This process, the sample is easily to be polluted. So it need to be processed in ultra-clean lab. For obtaining exact lead isotope data, the tests always expend long time and cost high expenses.

The paper decomposed the rock samples in carius tube sample digestion, and tested the samples with ICP-MS. First weigh up 50 mg rock samples, use $\text{HF}+\text{HNO}_3+\text{HClO}_4$ mix acid to dissolve the samples in carius tube sample digestion, keep 48h in 190 °C, then fix the samples into constant-volume in 50ml, and test the samples with ICP-MS. Before testing, the ICP-MS must be debugged, make sure the oxide < 0.5%, dipole layer < 1%, 205 (Tl) in 10 ppb's response value > 12000cps/s. Through repeat test of the lead isotope standard material NIST NBS981, the degree of precision (<5% RSD) and accuracy meet the requirements of the applied research. In the lead isotope testing with international standard BCR-2 rock samples, the results consistent with the standard values. Then the paper tested the lead isotope in 10 rock samples, and obtained ideal analysis effects.

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The total mercury concentration in mosoon precipitation in Yangtze Delta

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Precipitation is the key role for the water-soluble Hg (II), which is the oxidized product of the elemental mercury (Hg) in atmosphere, to enter the earth surface ecosystem. Lots work shows that due to the “washing out” process, the mercury concentration at the early stage of the rain is highest and then gradually decreases. There are negative correlation between the mercury concentration and the amount of precipitation. However by the 1 year measurement of the mercury in precipitation in Yangtze Delta, we find that in summer season the mercury concentration in precipitation changes according to the types of the rain.

The hourly precipitations for each rain from six observation sites of Yangtze Delta have been being collected since Dec. 2008. The total mercury concentration and particle mercury concentration have been checked. The results show that in summer the mercury concentration in precipitation ranges from 0.04 to 0.22 μ g/L. In June, the rain season of East Asia, Yangtze Delta is controlled by the special frontal rain, called plum rain, and the mercury concentration in precipitation keeps constant during each rain process and there are no negative correlation between precipitation and mercury concentration. It is because the month long semi-static frontal causes the cloud droplet could form and evaporate in cloud boundary for several time and the in-cloud scavenging process become the main process for the mercury going to the droplet. In July and August the negative correlation appears, when in convective precipitation the mercury scavenging is controlled by out-cloud scavenging and then particle mercury concentration is higher.

Brightness temperature distribution of the moon: result from Chinese Chang'E-1 Lunar Orbiter

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We have obtained the γ ray, X-ray, UV-VIS-IR images of the moon from the past Lunar Orbiter, Clementine, Lunar Prospector and SMART-1 spacecrafts. In microwave frequency, Lunar Radar Sounder of KAGUYA (Japan) and MINI-SAR of Chandrayaan-1 (India) has obtained the active radar image of the moon. But the passive microwave radiometry was absent aboard these lunar orbiters.

Astronomers had observed the moon for a long history using ground-based radio telescope, brightness temperature (TB) distribution map of the nearside had been obtained (eg. [1]). The farside of the moon has not covered and spatial resolution should be enhanced. We also had known that heat flow and thickness of lunar regolith could be retrieved [2, 3].

A microwave radiometer was onboard Chang'E-1 lunar orbiter, which was working at the frequencies of 3GHz, 7.8GHz, 19.35GHz, and 37GHz. The global TB map of the moon had been derived in the figure below using the first month data. The offwhite strip was filled with the second month data. Other TB map and retrieval results from TB data would be present in the future.

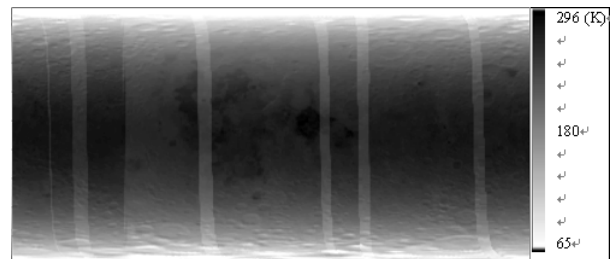


Figure 1: Daylight TB of the moon at 37.0 GHz.

The moon maps show that TB in higher latitude zone was lower than that in low latitude. Crater could be identified easily from the map, which suggests that TB is mainly controlled by lunar topography. TB of dark mare regions is higher than highland, more absorbing of microwaves, accounted for more abundant titanium-containing mineral ilmenite than highland.

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Arc-continent collision zones are primary sites of net continental crustal growth: Evidence from Neoproterozoic and Mesozoic magmatic rocks in the periphery of the Yangtze craton

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Neoproterozoic granitoids and gabbros in the periphery of the Yangtze craton are characterized by the arc-like patterns of whole-rock trace element distribution, the zircon U-Pb ages of 830 to 740 Ma and the bimodal composition of zircon Hf isotopes. Negative $\varepsilon_{\text{Hf}}(t)$ values with middle Paleoproterozoic Hf model ages occur in its southern and northeastern margins, whereas positive $\varepsilon_{\text{Hf}}(t)$ values and late Mesoproterozoic Hf model ages occur in its western, northern and southeastern margins. The contrasting features are attributed to reworking of ancient and juvenile crusts, respectively, which formed by continental and oceanic arc magmatism in response to the Grenvillian subduction of oceanic crust during assembly of supercontinent Rodinia. Additional zircon U-Pb dates gave 960 to 860 Ma for arc-continent syncollisional magmatism, signifying continental accretion around the Yangtze craton. Thus, the arc-continent collision zones are primary sites of net continental crustal growth.

On the other hand, Mesozoic intrusive and volcanic rocks along the Dabie-Sulu orogenic belt, typical continent-continent collision zone in east-central China, are characterized by the arc-like patterns of whole-rock trace element distribution and negative zircon $\varepsilon_{\text{Hf}}(t)$ values with Paleoproterozoic-Archean Hf model ages. They are clearly derived from reworking of the ancient crust that is part of the arc-continent collision orogen in the early Neoproterozoic. So far no syncollisional magmatism has been identified in the Triassic collision zone between the South and North China Blocks. Thus, the continental collision zone is not a primary site of net continental crustal growth. A plate-rift model is therefore advanced to account for various observations of petrology, geochemistry and tectonics, with tectonic collapse of collision orogens as the basic cause for crustal reworking. This model has potential applications to other orogens (e.g., Himalaya-Tibet and Central Asian Orogenic Belt) where preexisting arc-continent collision zones would have been consumed by continental collision.

Carbonate-salt inclusions in spinel-group minerals of the Merensky Reef and Phalaborwa complex

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The primary multiphase solid inclusions have been studied in chromite from pyroxenite-pegmatites of the Merensky reef and in magnetite from phoscoritic carbonatite of the Phalaborwa complex to compare compositions and formation conditions. Chromites of the Merensky reef central zone (the Dwars River area, eastern Bushveld, 2054±22 Ma) are zoned and associated with orthopyroxene En_{82-60} . Their core-to-rim variations are (in wt.%): Cr₂O₃-41.2-10.2; FeO-33.5-20.0; Al₂O₃-18.5-54.4; MgO-4.9-13.8. Solid inclusions (size - 10-200 μm) in chromite have oval or polygonal shape and commonly contain calcite, dolomite, quartz, NaCl, KCl, REE-apatite, MSS globule, ilmenite, zircon, magnetite and rare K-Na-phlogopite and clino- and orthopyroxene.

Magnetite from phoscoritic carbonatite at Loolekop mine of the Phalaborwa complex (~2060 Ma) approaches ideal FeFe_2O_4 with minor TiO_2 (1.0-1.7), MgO (1.2-1.7), Al_2O_3 and MnO (up to 0.2 wt. %). Solid decay microstructures of magnetite-ilmenite-ulvospinel and individual large lamellae of microilmenite are common in magnetite. Multiphase inclusions (size - 10-300 μm) have rounded or irregular shape and vary in mineral composition from carbonate to carbonate-silicate-oxide-chloride. Dolomite, calcite, apatite, microilmenite, phlogopite, magnesite, brucite are essential minerals in such inclusions. Minor phases are fairchildite, baddeleyite, uranothorianite, strontianite, witherite, barite, celestine, Ca-Ba-carbonate, bastnaesite-(Ce), Na-REE apatite, NaCl, KCl, Fe-Ni-Co-Cu sulfides and Au-Ag alloys. The carbonate inclusions usually vary in calcite-dolomite ratio and calcite sometimes contains perthitic dolomite.

The similarity in phase composition of carbonate-salt solid inclusions in the spinel-group minerals of the Merensky reef and the Phalaborwa complex seems to be evidenced about the possible participation of carbonate melt during crystallization of the Merensky reef pyroxenite-pegmatites. Contamination of mafic melt by carbonatite liquid or separation of initial melt into mafic silicate and carbonate components most likely to be dominating processes of their evolution.

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Ordered chain of nanomagnetite: Implication for magnetosome mineralization

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Magnetotactic bacteria (MTB) are a diverse group of microorganisms that have the ability to use geomagnetic fields for orienting with the help of magnetosomes, nano-sized magnetite crystals enveloped by a lipid bilayer membrane. Because of the distinctive properties of magnetosomes and their chain-like alignments, MTB and their biomineralization have intensively been investigated in diverse disciplines from geomicrobiology to biotechnology. Several studies suggest that specific proteins, such as Mms6, MamK, and MamJ, may be directly involved in biomagnetite formation and their assembly into chains. Our experiments in the absence of bio- or organic-macromolecules show that an ordered arrangement of nanomagnetite crystals similar to the magnetosome chains can be obtained through an inorganic synthetic method at low temperature. XRD, Micro-Raman, SEM, and HRTEM indicate that the ordered chains are self-assembled by roughly cuboidal nanomagnetite crystals, and the cuboidal nanoparticles in the chains are connected, face to face, with {100} or {111} facets. Therefore, a magnetic dipole-dipole interaction mechanism is proposed for the formation of magnetite chains. This implies that in MTB, except for some specific proteins, the dipole-dipole interactions may also contribute to the organization of magnetosomes into chains. It appears that biological genetic and crystallochemical factors may synergistically operate in the formation of magnetosome chain in MTB. In addition, our experimental results show that a weak alkalic environment (pH = 8.0) is essential to form cuboidal nano-magnetite that is similar to the morphology of magnetosome magnetite found in some MTB. This suggests that in the membrane vesicles a favorable pH to the growth of cuboidal crystals should be close to 8.0. Therefore, membrane vesicles in MTB not only furnish specific proteins to direct the nucleation and growth of mineral phase, but also function as an incubator of magnetic crystals by supporting a suitable alkali environment. These results may contribute to deepen understanding of the entire circumstance of magnetosome formation and chain assembly and to improved knowledge of functions of magnetoreceptive organelles in vivo.

SHRIMP zircon U-Pb dating and geochemical characteristics of the Guiken pluton, south China: Implication for early Mesozoic tectonic evolution

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Guiken pluton is located at the boundary area of Jiangxi, Fujian and Guangdong Provinces as a batholith, in broad north-south stretching, with a total area of ca. 700km². Zircon U-Pb ages and geochemistry of Guiken are reported here to decipher the early Mesozoic tectonic evolution.

The granite batholith were emplaced at 220.4±3.2Ma, belonging to Indosinian periods. It mainly consists of medium-coarse grained biotite granite. It exhibits metaluminous and peraluminous characteristics, in major element compositions (A/CNK=1.03 to 1.29), enriched in SiO₂ (from 70.55% to 76.55%), total alkali (K₂O+Na₂O from 6.9% to 9.8%), and has high FeO*/MgO ratios (3.24 ~ 7.94). In trace elements, it has high LILE (such as Rb, Th, U, Zr, Y) and LREE and depleted in HREE and HFSE. It has significant negative Eu anomalies and depletion of Ba, Sr, Nb~Ta, P, Ti in primitive mantle normalized spiderdiagrams. Isotopically, it has high initial Sr ratios (from 0.710~0.726) and pronounced negative εNd(t) (from -8.6 to -10.2), and T_{2DM} values is between 1.60Ga to 2.03Ga.

In comparison with related geology, petrology and geochronology of granites in adjacent regions [1-3], it can be concluded that Guiken pluton belongs to the crust-source S-type granite formed by partial melting of Proterozoic meta-greywacke in post-collisional stage after the major collision of Indosinian Movement in Indo-China Peninsula.

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Paleoenvironment Research of Quaternary Period using fluid inclusion in Puding stalactite of karst cave, Guizhou Province, China

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Fluid inclusions are widely spread throughout the chemical sediments of karst caves. These fluid inclusions, formed during the course of chemical sedimentation, contain a great deal of important information about paleoenvironmental evolution and climatic transition. The stalactite samples of Puding karst cave in Guizhou Province, formed during the Quaternary epoch, were collected to study the characteristics of fluid inclusions found inside different laminas. Using the thermodynamic method, the constitutional equilibrium constants of fluid inclusions, the fluid density ratio, the component content ratio, and the different solubility are used to determine whether the fluid component in the inclusion of the karst cave sediments leaks or not. The homogeneous characteristic of gas-liquid inclusion inside the karst cave sediments is analyzed and the uniform temperature of the inclusion captured in the single phase is used to calculate the thermodynamic parameters, including temperature and pressure values that were in place when the fluid inclusion had been captured. This process provides a way to obtain information about the climate and hydrographic environment – the air temperature, pressure, concentrations of CO₂ and pH value, concentrations of HCO₃ and CO₂ of the underground water solution, and saturation of CaCO₃ and MgCO₃ – in Pleistocene Period. It presents the relationship between the hydrographic environment among crystal movements and climatic changes, paleoenvironmental changes, luxuriance and degeneration of vegetation, and the underground water property, which is of great scientific value and theoretical significance. This allows for the reconstruction of the Paleoenvironment of the Quaternary Period.

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Organic geochemistry of oils from the Junggar Basin of Northwestern China

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The Junggar basin of northwestern China contains abundant petroleum resources, whose oil and gas are generated from source rocks of Carboniferous, Permian, Jurassic and Tertiary age. Analyses of 96 oil samples from more than 16 fields mainly located in western, central, southern and eastern part of the Junggar basin revealed that carbon isotopic compositions of crude oils from the Junggar basin are in the range of -27–33‰, most values are -29–30‰. Combined with biomarker compositions of oils, four genetic oil types could be divided. Main type oils generated from three Permian source rocks (Jiamuhe, Fengcheng and Wuerhe Formation) occurred in oilfields of western margin and central area of basin. Another important types of oils with heavier carbon isotopic values (-26–28 ‰) and higher Pr/Ph (>2) are present in eastern Fukang sag, Dushanzi oilfield, Dongdaohaizi sag and Qigu oilfield, which are derived from Jurassic coaly organic matter.

Thermal maturity sequences of oils from a single source rock can be used to estimate pathways of oil migration, oils formed in the late stage are more mature than oils formed in the early stage. Based on the stable carbon isotope signatures and Ro values calculated from methylphenanthrene indicator of oils, the directions of oil migration have also been obtained in the central area of the Junggar basin. The oils from Shixi, Shinan, and Mobei oilfields mainly migrated from west of Pen-1 sag. However, Moshuwan oilfield are more complex, petroleum migrated and mixed from several directions including west of Pen-1 sag, Changji sag and possible dongdaohaizi sag.

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Spatial and temporal distribution and petrogenesis of Miocene ultrapotassic volcanism in Gangdese, Tibet

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We investigated Miocene ultrapotassic volcanism in the interior of the Gangdese belt in southern Tibet. The volcanic activity is characterized by scattered small-volume (0.45km², 78 km²) terrestrial flows. Two representative samples from Gongmutang, Zhongba County (N30°48.9', E84°26.0'), and another two from Mibale, Nimu County (N30°50.2', E86°39.43') are discussed here. These samples are potassium-rich (6.25% < K₂O < 7.87%) over a range of SiO₂ (50.85~58.41%) and Na₂O (1.88~2.71%) contents. Mg-number of sample CQ1 with MgO =10.72 wt % is 0.66, suggesting that it represent a relatively primitive melt, while others with MgO of 4.22 to 4.81 wt % are evolved ones.

Table 1: ⁴⁰Ar/³⁹Ar age data for Gongmutang and Mibale volcanic samples

Sample	Rock Type	⁴⁰ Ar/ ³⁶ Ar (Plateau Age in Ma)	1σ	MSW D
CQ1	phono-tephrite	16.10	0.12	1.80
CQ2	trachy-andesite	16.59	0.13	0.85
8030-5	trachy-andesite	13.47	0.13	1.60
8030-18	trachy-andesite	13.17	0.11	0.99

The ages obtained for samples with the more basic compositions are slightly older than the more evolved ones in both areas, indicating a high rate of eruption. Furthermore, on primitive mantle-normalized incompatible element diagrams, our samples resemble ultrapotassic rocks elsewhere in the Gangdese belt in having similar enrichments (i.e., high LREE/HREE ratios) and characteristic negative Sr, Nb, Ta, and Ti anomalies, suggesting similar petrogenetic processes.

A compilation of available ⁴⁰Ar/³⁹Ar age data on the Miocene ultrapotassic volcanic rocks indicates almost simultaneous volcanism in north-south direction at a given longitude in the interior of the Gangdese belt although it is also apparent that the ultrapotassic volcanism displays an eastward migration.

This research is supported by the Chinese NSF (40572048, 40672044, 40830317 and 40873023) and the National Key Project for Basic Research on the Tibetan Plateau (2009CB421000).

Study on the character of mineral pollution in soil from lead-zinc mining area

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As a absolutely necessarily component in biogeocenose, soil act as a important role in every circulation. Soil-plants system is a basic construction unit in terrestrial ecosystem, and also is the junction of the matter energy circulation in ecosystem. It is not only the most acitive environment factor on earth, but also is the cherishable renewable resource. If the system is polluted, not only the plants outputs and qualities will be affected, but the atmosphere and the water circumstance will also be affected.

The soil's main components is mineral substances, organic contents, live organic bodies, moisture, atmosphere and etc. The mineral substances weihgt occupy the solid phase weight (soil dry weight) of 90%~95%, or even more. So the main components in soil is mineral sustances.

In plumbum and zinc diggings, because of the exploitation, around soils were unavoidable polluted. The mineral sediment aroud the diggings with dust, stream and aerosol. That make the Pb pollution in the soil around the diggings. The paper used the SEM and X diffraction method to analysis the farmland soil in plumbum and zinc diggings, and found the zinc minerals in the soil mainly is PbCO₃, PbSO₄, PbS, PbCO₃·2Pb(OH)₂, and etc. The paper also analysed the conformation of the Pb in the soil, and found there is some connection with the conformation and the minerals. So, the research of Pb pollution in soil can not only through the conformation analysis, but also through the mineral research method. This provide a new path for the heavy metal pollution research.

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Tritium ventilation ages of waters along 36°N and 25°W in the subtropical North Atlantic Ocean

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The ocean plays an important role in climate variability and change. It transports heat on a global scale. Changes in ocean biogeochemistry can directly feed back to the climate system, for example, through changes in the uptake or release of active gas such as CO₂. However, the change in heat content and ocean carbon pump capacity are complicated systems and the controlling mechanisms have not yet been clearly identified. Ocean samples have been collected in a transect along 36°N in the Atlantic Ocean and an Atlantic meridional transect leg along 25°W. These ocean regions are critical for evaluating the ventilation ages which control the heat content change and identifying the regional variations in export production over the subtropical North Atlantic.

Besides measurements of nutrients, oxygen, carbon, SF₆ and CFCs in water samples, analysis of tritium-helium in waters provides age information measuring the time since the fluid was last in the mixed layer. The implied tritium-helium ages, which are optimal for ages less than 15 years, will complement the CFCs derived ages. The determination of tritium ages of water samples is essential for calculating rates, such as, the apparent oxygen utilization rate.

We present preliminary tritium results of waters along 36°N and 25°W in the subtropical North Atlantic Ocean. Tritium is present in bottom waters in most stations. Vertical profiles of tritium ventilation ages in all stations show that they have the expected maximum in the surface layer and decrease with depth. The horizontal distribution of tritium shows that ventilation rates are higher in the eastern part than in the western section of the 36°N transect. These tritium ventilation ages provide the basis for modelling mechanisms controlling heat content changes and estimates of export production.

Mafic magmatism in the Siziwangqi area of Inner Mongolia, China: Geochronology constraints and tectonic implications

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The Siziwangqi area is an important district for study of the paleozoic crustal growth and recycling of Xing-Meng orogenic belt along the northern margin of the North China Block [1-4]. Zircons separated from rock samples representative of three gabbro-dioritic plutons are dated by using LA-ICP-MS U-Pb dating method.

The Weijing dioritic pluton intruded into the green-amphibole facies metamorphic rocks in the western part of the Xilinhote-Sonidzuoqi belt. LA-ICP-MS U-Pb dating of zircons from this plutonic rocks yielded an emplacement ages of 508±10 Ma and a metamorphism age of 467±9 Ma. These results imply that subduction of the oceanic slab occurred at least before 500 Ma, and arc-continent collision took place around 460-400 Ma. The emplacement ages of the dioritic and gabbrotic plutons in the Siziwangqi county are 331±5 Ma and 302±2 Ma, respectively. These date marks the the initial time of the continent-continental collision between the North China Plate and Siberian Plate along the Xing-Meng orogenic belt.

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The geological disposal research of high-level radioactive waste in China

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Recently, with the impressive economic boom and development of technology in China, energy shortage has become a more and more serious problem. Nuclear energy is considered as one of the alternative solutions. Obviously, the issue on nuclear waste disposal becomes important actuality.

This article put forward that China has adopted an elementary technology route for the geological disposal of high-level radioactive waste which includes three stages: siting and site characterization, underground research laboratory for a site-specific, and repository. The objectives are the completion of Chinese high-level radioactive waste geologic repository around 2030-2040 [1-2]. The disposed waste are vitrified high-level waste, transuranic waste and some spent fuel. The repository is shaft-tunnel-type, located in the saturated zone [3-4]. The Beishan area in Gansu Province is thought to be the most appropriate area because of its Gobi desert location, stable crust and rare inhabitants as well as its good geological and hydro-geological condition [5]. For the repository bentonite is chosen to use as a kind of backfill. A large amount of deep geological data, adsorption and diffusion, associated with radioactive-nuclides' transportation in granite and bentonite [6]. The devices used to simulate temperature, pressure and redox condition of the repository have also been established [7]. Studies on siting evaluation, geochemical behavior of radioactive nuclides, buffer material, and environment impact assessment are being carried out in depth. The cooperation with the international Atomic Energy Agency have been very fruitful [8].

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Phosphate nodules from the lower Cambrian Niutitang Formation black shale in Yangtze block, NW Hunan province, China: Implication for early diagenetic processes

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Phosphate nodules are widely distributed in early Cambrian black shale sequence in Yangtze block, south China. In this study, we sampled phosphate nodules of various size from two PC-C sections from Hunan province and analyzed redox-sensitive trace elements, rare earth elements, and Sr isotopic compositions of both the nodules and host black shales from the Niutitang Formation of Lower Cambrian stata in northwest Hunan province.

The results show that the phosphate nodules show symmetry in geochemistry which imply the core-rim growth pattern of phosphate nodules. Bigger nodules show seawater-like shale-normalized REE patterns, which may represent the characteristics of pore fluids during very early diagenetic stage; whereas those smaller nodules show MREE-rich patterns, which should represent a typical feature of diagenetic pore fluids in the organic-rich sediments. Ce anomaly in the phosphate nodules reveals a gradually reduced environment during the process of early diagenesis. Weak positive Eu anomaly and high U/Th ratios in some nodules may suggest involvement of hydrothermal fluids during nodule formation process, which is in line with the hydrothermal model proposed by many researchers for the Ni-Mo polymetallic sulfide marker bed just above the phosphate nodule riched black shale layer in the same area [1-3]. Higher than coeval seawater ⁸⁷Sr/⁸⁶Sr ratios (0.71028-0.71251) of the phosphate nodules indicate a radiogenic Sr contribution from the host organic-rich mudstone, possibly during diagenetic processes.

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New experimental data and modeling results of coupled alkali feldspar dissolution and secondary mineral precipitation

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In order to evaluate the complex interplay between dissolution and precipitation reaction kinetics, we conducted a series of batch and flow through reactor experiments to assess alkali-feldspar dissolution and secondary mineral formation in initially acidic fluids (pH = 3 -4) at 200°C and 300 bars. Temporal evolution of fluid chemistry was monitored by major and trace element analysis of *in situ* fluid samples. Solid reaction products were analyzed with scanning electron microscopy, X-ray diffraction, transmission electron microscopy, and X-ray photoelectron spectroscopy.

The experimental data allowed us to examine the hypothesis of partial equilibria between secondary mineral products and aqueous solutions in feldspar-water systems. Speciation and solubility geochemical modeling was used to compute the saturation indices (SI) for product minerals and to trace the reaction paths on activity-activity diagrams. The modeling results demonstrated: (1) the experimental aqueous solutions were supersaturated with respect to product minerals for almost the entire duration of the experiments; (2) the aqueous solution chemistry did not evolve along the phase boundaries but crossed the phase boundaries at oblique angles; and (3) the earlier precipitated product minerals did not dissolve but continued to precipitate even after the solution chemistry had evolved into the stability fields of minerals lower in the paragenesis sequence. These three lines of evidence signify that product mineral precipitation is a slow kinetic process and partial equilibria between aqueous solution and product minerals were not held. In contrast, the experimental evidences are consistent with our new hypothesis that slow clay precipitation kinetics partly explains the well known field – lab rate discrepancy [1,2].

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Origin of basaltic underplating

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The origin of basaltic underplating is mistakenly attributed to that the mantle derived melts is denser than the typical lower crust due to the previous inaccurate arguments. Our density calculation of picrites shows it is not the case. We have developed a quantitative density barrier model and performed thermal simulations to evaluate the evolution of the magma intraplating and underplating process. At the initial stage of magmatism, the mantle-derived basalt is likely to stall at the base of the upper crust due to the density stratification of the continental crust. This is an intraplating process. The underplating is induced by melting of the lowermost crust, which produces a thin melt zone, serving as a physical density barrier for ascending basalts.

The density barrier model predicts that intraplating and underplating cannot simultaneously occur. In addition, the underplating cannot cause the melting of the upper crust, and basaltic intraplating cannot produce significant melts of the lower crust. Hence, intraplating and underplating have a different prospect for related mineralization due to the different element-abundance of the upper and lower crust. The occurrence of S-type granite and associated deposits and HTLP (high-temperature-low-pressure) metamorphism are a tripartite association, which is probably diagnostic of basaltic intraplating.

Several ways can lead to melting of the base of the lower crust. If the intraplating basalt with a high temperature and fast emplacement rate, this will result in a transition from intraplating to underplating. This is the case for mafic LIPs. The short-lived intraplating process can explain why S-type granite and adakite are absent in a mafic LIP.

In addition, coupled with the observations, our numerical results also predict that the intraplating is largely overlooked in many tectonic environments.

Geochemical characteristics and distribution of heavy oil degraded gas in China

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There is much shallow gas in heavy oil reservoirs in China. It's mainly biogenic gas that generated from the biodegradation process of crude oil under aerobic conditions and also called as heavy oil degraded gas. CH₄ is the main production, which shows a great exploration potential for CH₄ produced by biodegradation in petroliferous Basins in China. Lots of heavy oil degraded gas has been found in the west slope of Song Liao Basin, Bohai Bay Basin and the northwest margin of Jungar Basin [1]. Its burial depths generally range from 200m to 1000m.

The shallow gas is mainly dry gas, methane is the main component, with only a little heavy hydrocarbons(C₂+) and relatively high content of N₂. Methane carbon isotope is characterized by high negative values ranging from -75‰ to -50‰; Ethane carbon isotope is heavy, with the numbers ranging from -35‰ to -55‰, which is possibly due to the mixture of thermalgenetic gas; And CO₂ bears very heavy carbon isotope, some is up to +15‰~+20‰. On the whole, the methane of crude oil degraded gas are rich in light carbon isotope, the main reason is that methane bacteria select ¹²C as carbon source, and the thermodynamic carbon isotope exchange reactions are also favor for methane rich in ¹²C, while the more ¹³C remain in the remnant carbon dioxide [2,3]. The carbon isotopic fractionation is obvious in the biodegradation process of crude oil.

The reservoir was in an open environment during the formation period of heavy oil. Surface water containing oxygen and microbes infiltrated into the oil pool so that crude oil was densified by oxidation, water washing and aerobic degradation. Once free oxygen was consumed out, N₂ became enriched and anaerobic degradation producing CH₄ started. So heavy oil degraded gas always bears high content of N₂.

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Magma mingling origin of mafic microgranular enclaves in Guposhan granite pluton, South China

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The mafic microgranular enclaves (MMEs) are widely distributed in the central part (Lisong district) of the A-type Guposhan granite batholith, western Nanling Mountains, South China. The MMEs are dioritic to gabbroic in chemical composition, characteristic of variable sizes, oval to irregular shapes, fine-grained dark biotite-rich margins, frequently with felsic halos and back-veining. The xenocrysts of K-feldspar are unevenly spreaded in MMEs, sometimes straddling the granite-enclave boundaries. The corroded margins and rapakivi-like texture are not rare. Under the microscope, the MMEs often possess diabasic texture. The oscillatory zoned phenocrysts of plagioclase, alignment of elongate laths of twinned plagioclase and acicular apatite are very common.

Chemically, all the MMEs, the Lisong hosting granite and the Guposhan major phase granite are enriched in alkalis, LILEs and HFSEs, showing obvious A-type granite features according to the classification of Whalen *et al.* (1987) and Eby (1992). In the major and trace elements geochemistry, the Lisong hosting granite is transitional between the MMEs and the Guposhan major phase granite.

The single grain zircon SHRIMP U-Pb dating reveals coeval isotopic ages of a large enclave (4.5 m across) and its hosting granite (162±2 and 162±3 Ma, respectively), which excludes the possibility of the restite of melted metamorphic rocks in the lower crust and the entrapped pieces of country rocks in the shallower depth. Their significant difference in chemistry and texture excludes the possibility of co-magmatic segregations and/or cumulate of earlier stage crystallization for the MMEs.

The I_{Sr} values of MMEs and hosting granite are 0.70473 and 0.70664~0.70742, respectively. Their εNd(*t*) values are +1.94 and -1.72 ~ -3.07, respectively. Their zircon εHf(*t*) values are in the range of +2.6~+7.4 and -3.7 ~ +0.3, respectively. While the I_{Sr} and εNd(*t*) values of most S-type high-K calc-alkaline granites in Nanling Mountains region are in the range of 0.710~0.722 and -9.0~-12.0, respectively.

All these integrated geologo-geochemical data demonstrate that the Lisong hosting granite is the mixing product of the Guposhan granite melt with the intermediate-basic magmatic melt, the Lisong MMEs are the remnants of incomplete mingling from the intermediate-mafic magma, and the mafic components of these rocks were derived from the depleted mantle end-member.

Testing primary origin and duration of the largest negative $\delta^{13}\text{C}$ excursion in the Ediacaran ocean: Insight from South China

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The largest ever negative $\delta^{13}\text{C}$ excursion (nadir of -12‰) has been reported from mid-Ediacaran carbonates in Australia, Oman, Norway, Scotland, Siberia, South China and western USA. It was proposed to result from the rapid oxygenation of the Ediacaran atmosphere and ocean which may have triggered the evolution of macroscopic multicellular life and subsequent diversification of animals. However, the primary origin and duration of the excursion remain under debate, thus challenging the model for the Neoproterozoic carbon cycling and oxygenation.

The excursion in South China, termed as the DOUNCE event, occurs at the top of the Doushantuo Formation with an age of 551 Ma for its termination. New results through high-resolution stratigraphic investigations of the uppermost Doushantuo Formation of South China reveal that the DOUNCE event always occurs within the transgressive systems tract of a sequence, and represents a widespread isochronous $\delta^{13}\text{C}$ excursion with decreasing gradient of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values from the platform interior to slope and basal facies, suggesting stratification of seawater. In general, $\delta^{13}\text{C}$ values within the DOUNCE excursion range from -10‰ to -7‰. High-resolution C and O isotope and petrographic analyses of laminated carbonate samples within the DOUNCE excursion indicate that $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values show constant positive covariation between the limy and dolomitic laminae with constant deviations (1.3‰ for $\delta^{13}\text{C}$ and 5.8‰ for $\delta^{18}\text{O}$). Similar deviations of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ have been detected between the limestone and dolomite at the same horizon from different sections. Such systematic mineralogical control on $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values is a good indication of a primary seawater signal, as it likely represents an original isotope fractionation possibly superimposed by periodic changes in ocean temperature, primary productivity or salinity of ocean. Present data reinforce the notion that the DOUNCE event represents a primary global ocean signal with a duration of less than 10 Ma.

Unravelling the exhumation history of the Precambrian basement rocks in the northern Tarim through apatite fission track thermochronology

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The Kuruktag Uplift is located to the north of the Tarim basin where the Precambrian crystalline basement rocks are widely crop out. An Archean complex occurs near Qingir village, and the Neoproterozoic strata occur in Xingdi, Xishankou, Xinger and Saimashan areas in the western Kuruktag, which unconformably overlie the Paleoproterozoic to Mesoproterozoic gneisses, amphibolites and schists and are unconformably overlain by the Early Paleozoic rocks. Thus, it is perfect place for understanding the thermal evolution of the Precambrian basement of the Tarim Basin. The purpose of this study is to detect that: 1. when were the basement rocks exhumed to the surface initially? 2. did the basement rocks of the Tarim craton experience reburial and re-exhumation? and 3. the history of thermotectonic evolution of the basement rocks respond to the different tectonic events occurred at Tarim continental margins. In order to obtain information about the exhumation history and processes of cooling in the northern Tarim, fission track methods on apatite were used. Ten apatite-bearing samples were collected from two sides of the Xingdi fault in the Kuruktag Uplift. Pooled ages range from 146.0 ± 13.4 to 67.6 ± 6.7 Ma. Mean track lengths range from 11.79 ± 0.14 to $13.89 \pm 0.27 \mu\text{m}$. These samples can be divided into three groups depending on their ages and structural position. Group A will refer to samples F2-F3-F4-F5 and F8 with AFT apparent ages about 100-110 Ma., generally associated with areas undeformed by the faults. Group B will refer to samples F7-F9 and F10 with AFT apparent ages lower than 80Ma, mostly structurally associated with hanging wall situations close to the faults. Group C will refer to sample F11 which has the oldest apparent age of 146.0 ± 13.4 Ma. The thermal history modeled result shows four periods of exhumation in the Kuruktag uplift occurred in late Early Jurassic (180Ma), Late Jurassic-Early Cretaceous (144-118Ma), early Late Cretaceous (94-82Ma) and Late Cenozoic (about 10Ma). These uplift events recorded by the apatite fission track data in the Kuruktag are assumed to be in response to the result of far-field effects from the multi-stage collisions and accretions of terranes in the south Asian continental margin.

The study on volatile petroleum hydrocarbons (VPH) in soils from refueling service station in Beijing, China

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The VPH generated by the light-density fuels during the process of storage and transportation in refueling service station can bring about a series of negative influences to health, environment, safety. The surface soils about 5-30cm from three refueling service stations of North Fifth Ring Road and two of the side road to airport, which were put into wide mouth bottle with a brown and sealed in cryopreservation. Another surface soil sample came far away from refueling service stations by comparison. The composition of VPH in 5g accurate soil samples were identified and quantified by purge-and-trap gas chromatography-mass spectrometry, using the improved Method Massachusetts VPH. A standard VPH mixture included aliphatic of C5-C7 (pentane, hexane) and (octane, decane, dodecane), aromatic of C9-C12 (1,2,3-trimethylbenzene, naphthalene), MTBE, benzene, toluene, ethylbenzene, m/p-xylene and o-xylene. The result shows that VPH values of samples at refueling service stations are higher than the comparative sample. However, all samples did not detect MTEB. Aliphatic of C5-C7 and toluene could be detected in all samples at refueling service stations, and the value of aliphatic of C5-C7 is highest among the VPH, followed by toluene. One of refueling service station at the side road to airport, the experimental data shows that VPH values of the sample are obviously higher than others, and the total value of VPH is up to 570.25ng/g. The main component of VPH is the same in all samples at refueling service stations, which means pollutions of VPH in soil of refueling service station mainly comes from violate and deposition of VPH. Therefore, refueling service station should improve the corresponding technology to control volatile of petroleum and repair the polluted soil.

Geochemical data analysis of Deh-Salm area using neuro-fuzzy networks

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All previously discovered ore bodies in the Lut (east of Iran) ore field are Cu-Mo porphyry mineralization type and located in the places where dilational fault zones cut the contact zone of the Deh-Salm granitoid complex [2]. Conventional geochemical exploration models, which are used for determining anomalies in both local and regional scales, are generally based on multi-variable statistical analysis, metallometry survey, vertical geochemical zonality and other geochemical methods. In general, these methods have several limitations: 1) the separation of anomalies, which their data do not have normal distribution, is problematic, 2) the separation of anomaly from background, where the anomaly is associated with the formation mechanism, is difficult, 3) the results of various anomalies do not correlate on contour maps, and 4) the preparation of pattern recognition for various anomalies is not suitable. These limitations cause the process of interpretation to be time-consuming and costly. It seems that the method of neuro-fuzzy networks for specific mining geochemistry is very proper [1]. Fuzzy theory considers uncertainties in recognition of multiple anomalies and artificial neural networks possess high capabilities in learning existing models. The combination of these two tools creates a suitable technique for recognizing multiple anomalies, and is capable of using standard exploration existing models and considering their uncertainties, and thus, reduces exploration costs and produces reliable results. This technique has been used in this thesis to discriminate dispersed mineralization zones from blind mineralization zones. The results obtained by applying this technique are in good agreement with the results obtained using conventional methods, and in addition, the technique does not contain the above limitations mentioned for conventional methods.

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Effects of relative humidity on aerosol light scattering

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In the field, continuous measurements of aerosol light scattering are often performed under dry conditions (relative humidity RH < 30-40%) which differ from ambient, climate relevant ones. Since ambient aerosol particles experience a hygroscopic growth at enhanced RH, their microphysical and optical properties are strongly dependent on RH. The knowledge of the RH dependence is of eminent importance e.g. for climate models and for the comparison of ground based observations with remote sensing data. The goal of this study is to investigate the effects of RH on aerosol optical properties for different aerosol types. For this, we installed a newly developed humidified nephelometer (WetNeph) at different European measurement sites. The WetNeph measures the aerosol scattering coefficient at controlled RH.

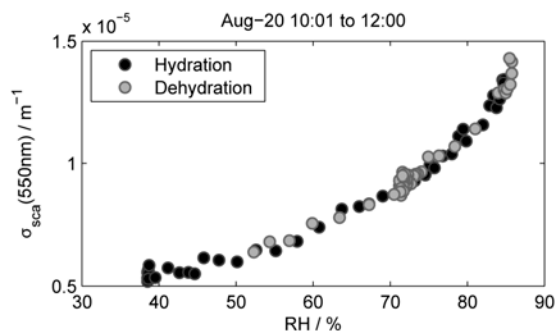


Figure 1: Humidogram of the aerosol light scattering coefficient (at 550nm) measured at Zeppelin station, Ny-Ålesund, Spitsbergen.

Figure 1 demonstrates the effect of RH on the scattering coefficient of arctic aerosol. Compared to the dry conditions the scattering is enhanced at 85% RH by a factor of ~2.5 on that day. At Jungfraujoch, Switzerland, scattering enhancement of up to 3.5 has been observed in May 2008 (not shown). Here, we will present results of our comprehensive field campaigns performed at Jungfraujoch and at Zeppelin station, Spitsbergen.

Silicon isotope fractionation between silicate and metal from an enstatite meteorite

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We have investigated the isotope fractionation between Si in metal and Si in silicate in meteorites in order to test the assertion that there is a strong Si isotope fractionation between core and mantle during planet formation [1].

Mt. Egerton (USNM 3272) is an enstatitic meteorite formed from E-chondrites. It consists mainly of coarse-grained enstatite and metal, the latter with 2.06 wt.% Si. Our MC-ICPMS acid digestion analyses show that the $\delta^{30}\text{Si}_{\text{NBS-28}}$ value of Si in the metal is 5.3 ‰ lower than that of Si in the enstatite. This fractionation from a natural system confirms results of recent experiments by Shahar *et al.* [2], which show a large $^{30}\text{Si}/^{28}\text{Si}$ fractionation between Si in silicate and Si in metal at high temperatures. The natural data exhibit a larger fractionation than that observed in the laboratory, likely due to the lower formation temperature of Mt Egerton.

We show that the slow rate of Si tracer diffusion in silicate, despite a more rapid tracer diffusion rate in FeSi, rules out post-crystallization diffusive resetting of Si isotope ratios. Therefore, the measured $\Delta^{30}\text{Si}_{(\text{silicate-metal})}$ is reflective of the crystallisation temperature of the meteorite. Theoretical Si isotope fractionation calculations [1], combined with experimentally obtained fractionations [2], predict a temperature of 1145 K (872°C) for a $\Delta^{30}\text{Si}_{(\text{silicate-metal})}$ of 5.3 ‰. Such a temperature is reasonable for this rock [3, 4]. We conclude that $\Delta^{30}\text{Si}_{(\text{silicate-metal})}$ has potential as a thermometer.

The differences in $\delta^{30}\text{Si}$ between metal and silicate, now demonstrated in meteorites and in the laboratory, show that Si isotopes can be used to constrain the amount of Si in Earth's core and/or the degree of equilibration during core formation.

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Matrix composition and community structure analysis of a novel bacterial pyrite leaching community

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Pyrite is the most abundant sulfide mineral in the earth's crust. The oxidation of pyrite leads to the release of ferric iron and - via several steps - of sulfuric acid. This causes a dramatic decrease of the pH value which in turn leads to a serious environmental problem. This process called acid mine drainage (AMD) is greatly accelerated by bacteria that catalyze the rate limiting step of pyrite oxidation, namely the reaction from ferrous to ferric iron. Here we report about a novel bacterial community that is embedded in a matrix of carbohydrates and bio/geochemical products of pyrite oxidation. This community grows in stalactite-like structures on the ceiling of an abandoned pyrite mine at pH values of 2.2-2.6. We measured sulfate concentrations of 200 mM and total iron concentrations of 60 mM in the soluble fraction of the matrix. Micro-X-ray diffraction analysis showed that jarosite is the major mineral embedded in the biofilm. X-ray absorption near-edge structure experiments at the ANKA (Karlsruhe) SUL-X beamline revealed three different sulfur species, whereby the major signal was caused by sulfate. The other two peaks might correspond to organic sulfur compounds. Arabinose was detected as the major sugar component in the extracellular polymeric substance. Via restriction fragment length polymorphism analysis, we elucidated the community structure. It consists mainly of iron oxidizing *Leptospirillum* and *Ferrovum* species but we also found microorganisms that could be involved in the dissimilatory sulfate and dissimilatory iron reduction.

Deciphering the roles of H₂O and fO₂ during calc-alkaline differentiation

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Determining the origin of tholeiitic (TH) versus calc-alkaline (CA) magmas has been clouded by issues of classification, definition, and multiple petrogenetic hypotheses. As variation in Fe is the salient feature in many TH-CA discrimination diagrams, we present a quantitative index of Fe-enrichment, the Tholeiitic Index (THI): THI = Fe_{4.0}/Fe_{8.0}, where Fe_{4.0} is the average FeO* of samples at 4±1 wt.% MgO*, and Fe_{8.0} is the average FeO* of samples at 8±1 wt.% MgO*. Magmas with THI>1 have become enriched in FeO* during differentiation and are TH; magmas with THI<1 are CA. Most arc magmas are CA, but the THI expresses the continuum of Fe-enrichment observed in magmatic suites of all tectonic settings.

One prominent hypothesis for CA magmas in arcs is high magmatic H₂O, which suppresses silicate crystallization relative to spinel, causing early Fe-removal and CA differentiation. However, high fO₂ also promotes early spinel (magnetite) crystallization. We explore these effects using melt inclusions (MI) from eight volcanoes in the Aleutian arc, which spans the arc global array in both H₂O and THI. We use S contents of MI as a proxy for fO₂ in the mantle wedge, and the Mg# of each suite at magnetite saturation, to deduce high- and low-fO₂ volcano groups. Within each group, H₂O strongly correlates negatively with THI. Overlapping H₂O contents between f groups suggests hydration and oxidation are not always coupled in the mantle wedge. Thus, there is a first order relationship between H₂O and THI in all tectonic settings, and a secondary relationship between THI and fO₂ in arcs.

Out of this world crude oil – Separating meteoritic and hydrocarbon Re-Os components

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Recent application of Re-Os geochronology and ¹⁸⁷Os/¹⁸⁸Os tracer studies to hydrocarbons affords petroleum geologists access to techniques successfully utilized by the mineral industry for the past decade. The ability to determine directly the age of a black shale and/or resultant maturation product sheds light on the absolute timing of hydrocarbon production and migration. The ¹⁸⁷Os/¹⁸⁸Os ratio serves as a tracer to the hydrocarbon source. Much experimentation is ongoing to apply the methodology to petroleum exploration. Here we report analyses of four aliquots from a single sample of impact-derived crude oil from the Solberga Quarry, Siljan, Sweden. Rhenium concentrations were notably consistent at ~1.5 ppb, whereas osmium concentrations ranged from 40 to 300 ppt. The expected age, if the crude oil was generated upon bolide impact, is ~377 Ma based on Ar-Ar analyses of melt breccias. The initially determined Re-Os isochron “age” of ~810 Ma with an ¹⁸⁷Os/¹⁸⁸Os initial value of ~0.2 presents an impossible result, given that both host and source rocks for the oil are Ordovician. We are constructing analytical tests to remove the Re-Os impact signature from the crude oil mixture. These tests will determine if dissolved components (vaporized meteorite) within the crude oil or solid meteorite detritus suspended in the crude oil produced the mixing line with Neoproterozoic “age” and low ¹⁸⁷Os/¹⁸⁸Os ratio. By passing the sample through various filter media, the liquid crude may be separated from any detritus and the resultant components individually analyzed to define relative contributions. Subsequent modifications to published procedures will depend on where the Re- and Os-rich components reside. Additionally, further refinement of analytical procedures and, equally important, sampling protocols may lead to higher precision, improved sample throughput, and an overall increase in the robustness of the methodology in complex systems. Successful separation and isolation of Re-Os components within a crude oil sample attest to the future of Re-Os tracer studies in migrated hydrocarbons, including those in unusual geologic settings.

Unroofing the Kalahari craton: Provenance data from Neoproterozoic to Paleozoic successions

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The formation of the Kalahari craton ended with massive Mesoproterozoic tectonic processes, but hosts the history of the craton evolution since the Paleoproterozoic. We sampled more than 50 Neoproterozoic to Devonian sedimentary formations from the western and southern margin of the craton to decipher a typical Kalahari/Kaapvaal provenance. Major peaks for detrital zircons revealed an overwhelming abundance of Mesoproterozoic zircons (1.4 – 1.0 Ga) reflecting the Natal and Namaqua orogenies with multiple collisional phases. Zircons older than 1.8 Ga were not found in the samples. Other major peaks reflect tectonic processes during the Ediacara and Cambrian. The mostly immature Neoproterozoic rocks host partly an active margin provenance but no definite arc signature. Detrital zircon data, whole rock Pb and Nd isotope analyses resemble the existent data from Patagonia, and Antarctica fragments. We propose therefore, that an exotic block (Patagonia) represented the actual Neoproterozoic arc terrane and rifted away during the Paleozoic. The immature Devonian Bokkeveld Group hosts surprisingly Silurian to Lower Devonian zircons related to magmatic activity at the western and southwestern margin of the Kalahari craton, so far understood to be a passive margin. Massive pyroclastic activity is recorded only in Eastern Argentina, associated with a formerly Neoproterozoic Hirnantian glacial diamictite (now dated as 485 Ma) and quartz-arenites. The origin of this magmatic event is unknown. Our study demonstrates that detrital zircon data should be treated carefully if used for “understanding a cratonic fingerprint” as characterising magmatic events might not be reflected at the margins of a craton.

Isotopic fractionation and reaction kinetics of Cr in aqueous solutions

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Mass-dependent variations in the isotope composition of redox-sensitive elements like Cr, Fe, Mo, and U show great potential to decipher redox-changes in the present and past oceans, and as such to unravel Earth's climate history. However, to correctly interpret isotope variations of these elements in geological archives, it is imperative to understand their fractionation behaviour during redox transitions and the involved reaction kinetics. Therefore, we experimentally determined the mass-dependent chromium isotope fractionation during Cr(VI) reduction, Cr(III) oxidation, as well as the isotope exchange kinetics between soluble Cr(III) and Cr(VI).

All chromium isotope measurements were performed by high-resolution MC-ICP-MS [1]. The influence of the pH conditions on the Cr isotope fractionation factor and the type of fractionation (i.e. equilibrium vs. kinetic) were investigated during Cr(VI) reduction. The constant difference in $\Delta(^{53,52}\text{Cr})_{\text{Cr(III)-Cr(VI)}}$ of $-3.54 \pm 0.35 \text{ ‰}$ (1 SD, N = 4) with different fractions of Cr(VI) reduction under strongly acidic conditions clearly demonstrates equilibrium Cr isotope fractionation. This $\Delta(^{53,52}\text{Cr})_{\text{Cr(III)-Cr(VI)}}$ value is within uncertainty equal to that of $-3.4 \pm 0.1 \text{ ‰}$ that was published for Cr isotope fractionation at pH 6 to 7 [2]. The outcome of our reduction experiments at pH = 7 is less clear as they invoke overlapping processes, some of which are clearly kinetic in origin. The oxidation experiments in alkaline milieu indicate much smaller Cr isotope fractionation – $\approx 0.5 \text{ ‰}$ on the $^{53}\text{Cr}/^{52}\text{Cr}$ ratio – than the reduction experiments.

The isotope exchange kinetics between soluble Cr(III) and Cr(VI) were investigated by means of enriched ^{50}Cr isotope tracer experiments. Over the timescale of weeks, no measurable isotope exchange between soluble Cr(III) and Cr(VI) was found, independent of differences in pH conditions and Cr(III):Cr(VI) ratios.

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Tracking the movement of the ITCZ from the last interglacial to the present: Evidence from Seychelles corals, western Indian Ocean

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In climate models the Indian Ocean is the region with the largest spread and the austral summer season is often not considered. However, the winter monsoon is crucial for precipitation over sub-Saharan Africa, Madagascar, Indonesia and West Australia. In addition, the winter monsoon season is strongly affected by the El Niño-Southern Oscillation (ENSO). Little is known about past changes of austral summer intra-seasonal variability (ISV) and its linkage with the position of the ITCZ. Here, we investigate changes in past seasonality and ISV during former Interglacials and from the Mid-Holocene to the present obtained from geochemical proxies (Sr/Ca, $\delta^{18}\text{O}$) in corals from the Seychelles located in a key region of ISV in the western Indian Ocean.

We hypothesize that the strength of the ISV variability over the western Indian Ocean in combination with changes in incoming solar radiation are crucial to explain the weak ENSO magnitude during Interglacials and the Mid-Holocene.

Anammox in terrestrial ecosystems: Distribution, diversity and activity

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Introduction

Denitrification and anammox, the anaerobic microbiological conversion of ammonium with nitrite (or nitrate) to N₂, are the only processes closing the global nitrogen cycle. Anammox is increasingly recognized as an important process in wastewater treatment and nitrogen cycling in marine ecosystems [1]. In oxygen minimum zones and surface sediments it may contribute to up to 60% of total N₂ production. Conversely, nothing is known to date about distribution, diversity, and activity of anammox bacteria in terrestrial realm. A variety of soil was tested for the presence of anammox bacteria using a nested PCR approach. The identity and diversity of anammox bacteria was assessed by cloning/sequencing of the 16S rRNA gene, and anoxic soil incubations with ¹⁵N-labeled substrates were employed to detect anammox activity along soil profiles.

Results and Conclusions

Anammox bacteria were detected in wetland soils, lake-shores, a contaminated porous aquifer, permafrost soil, marsh sediment, agricultural soil, and in soil samples associated with nitrophilic plants. However, anammox bacteria were not present in all tested soil types or soil fractions, demonstrating their heterogeneous distribution and their specific ecological requirements. Candidate genera 'Brocadia', 'Kuenenia', 'Scalindua', 'Anammoxoglobus', 'Jettenia', and two unidentified clusters were detected, suggesting a higher genus level diversity than in marine environments where mostly 'Scalindua' is found. Low anammox activity was detected at different depths along selected soil profiles. The activity varied with depth and season but denitrification was always the dominant N₂-forming process.

[1] Kuenen J.G. (2008) *Nat Rev Microbiol* **6** 320-326.

Geological and geochemical characteristics and exploration potential of the 'continuous' hydrocarbon accumulation in China

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According to whether traps have clear boundaries and hydrocarbon accumulation characteristics, China's hydrocarbon accumulation can be divided into 'non-continuous' type with clear trap and 'continuous' type without clear trap. The former, such as Daqing oil field, Kela-2 gas field, has characteristics of obvious trap, secondary migration, and buoyancy promoting the hydrocarbon accumulation. The latter, such as the Ordos Sulige tight sand gas, Shanxi Qinshui coal-bed methane, Ansai large oil field and so on, has characteristics of no clear trap, mainly primary migration, and large-scale in-source or near-source distribution, and can not be exploited with conventional technology. The isotope fractionation effect of 'continuous' hydrocarbon accumulation is not obvious, showing in-source or near-source accumulation characteristics^[1]. CH₄ accounted for 88 ~ 94% in Sulige tight sand gas, while δ¹³C₁ is -30‰~-37‰, δ¹³C₂ is -25‰~-23‰. Comparably, CH₄ of coal-bed methane in south Qinshui Basin accounted for more than 95%, δ¹³C₁ is -62 ‰ ~ -27 ‰, mainly of -40 ‰ ~ -30‰, δ¹³C₂ is -25 ‰ ~ -12.5‰. δ¹³C₁ values of Sichuan shale gas and southeast Hainan gaseous hydrocarbon hydrates in the South China Sea are mainly of -30 ‰ ~ -50 ‰ and -34 ‰ ~ -29 ‰ respectively, which are due to pyrolysis. In Fuyu reservoir of southern Songliao basin, the crude oil's δ¹³C of 'continuous' reservoir in the basin center, slopes and uplift were very close to -30.3 ‰ ~ -31.6 ‰, showing the characteristics of inconspicuous carbon isotope fractionation effect and in-source or near-source hydrocarbon accumulation. In China, the 'continuous' oil and gas resources are 53.5 billion tons and 3.68 thousand billion cubic meters, respectively. The gas hydrates resource in the Slope and Uplift is about 60-70 billion tons (oil equivalent) within a sea area of one million square kilometers of the South China Sea. And the exploration and development potential of 'continuous' gas in China is great.

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Geochemical info of trace elements for the ore-forming process of ore-body 59 in the Shifengshan copper deposit, Yimen, Yunnan, China

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The ore-body 59 is strongly oxidated, locally including vein and spotted sulphides. Samples were tested with ICP-MS method. Element frequency distribution models show 3 groups: Cu-MgO-Sr-Co-V-Pb, K₂O-Na₂O-Mn-Mo-Ba, Cu-Zn-Bi. R-factor analysis produces 6 factors: petrogenic elements F₁ (Rb, Ti, Li, K₂O, Ba, Na₂O, Σ LREE), Cu-mineralization F₂ (-Sr, -MgO, -CaO; Bi, W, Zn, Cu), hydrothermal effects F₃ (Sn, Cr, Tl, Ni, Na₂O) and F₆ (Ge-Co-Ni), Zn-Pb-Cu-mineralization F₄ (Zn, Cd, Pb, Mo, Cu). Q-cluster analysis gives 4 groups: Zn- Cu -Mo-Pb mineralization group, K₂O-Ti-Ba-V-Na₂O in-coming exhalative elements, Cr-Ni basic elements, CaO-MgO-Sr-Mn wall rock elements. The geochemical anomaly sections present groups as CaO-MgO-Sr, K₂O-Na₂O-Ba, Zn-Cu-Pb-Bi, Cr-Co-Ni-W, Ti-V-Be-Mo. These results reveal at least two Cu-sources. Cu-mineralization elements were brought in by the K-Na-Mn-Mo-Ba-bearing fluids during the diapir forming; Secondly, Cu mineralization elements flowed in with the Cr-Co-Ni-bearing fluids by tectonic reformation and basic magma superimposition. Wall rocks provided few matellogenic materials. During the upthrust of Cu-bearing diapirs, fluids extracted matellogenic materials of Cu-Zn-Bi-W elements to form ores in the faded dolomite rocks; Subsequently, Cr-Ni and Cu-Pb-Zn were orderly concentrated, which reworked the early ore veins; The latest stage of underground hydrothermal fluids leached the sulphide ores to form the oxidated ore-body.

Gas character anomalies found in highly productive shale gas wells

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Stable carbon isotope compositions of natural gases allow for numerous useful interpretations including the identification of "families", observing seals, detecting overpressure, and providing evidence of migrated thermogenic gas accumulations. In shale gas plays, where the source rock is also the reservoir, carbon isotopes of ethane and propane are robust thermal maturity indicators and can be accurately calibrated against measured vitrinite reflectance values. The calibration is particularly useful when coupled with mud gas isotope analyses where gas samples from the mud stream are collected at specific depths and used to generate a "thermal maturity" log.

Stable carbon isotopes become increasingly heavier (more positive) with increasing maturity. However, in certain shale gas plays (including the Haynesville, Barnett, Fayetteville, Woodford and Marcellus) an interesting phenomenon occurs at high maturity where the ethane and propane isotope values begin to reverse and become lighter (more negative) than methane values. In these highly mature shale environments, laboratory testing suggests that *in situ* wet gas cracking occurs where larger molecules crack into smaller molecules with lighter isotopic signatures.

A key observation is that many of these "isotopically reversed" wells appear to be the most productive. One possible advantage might be higher reservoir pressures associated with an increase in the concentrations of smaller gas molecules. Furthermore, if the shale has moved past the kerogen and oil cracking stages to reach the wet gas cracking maturity level, the kerogen/shale is likely more brittle with increased porosity and permeability.

Gas isotopes are also used as a proxy for shale porosity and permeability. Large carbon isotopic shifts between mud and headspace gases correlate with zones of increased porosity and permeability. In conjunction with traditional logs, these data can be used to pick horizontal drilling positions and fracture intervals.

Primary microbial succession in a glacier forefield

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As the majority of Swiss glaciers are currently receding through global warming, the glacier forefields have become an interesting study site for primary microbial succession by phototrophic and heterotrophic microorganisms.

Here, we characterize the structure and composition of the colonizer communities in newly exposed rock substrates. This study is carried out within the framework of the CCES-*BigLink* interdisciplinary project of the ETH domain and the study site is the forefield of the Damma Glacier located in central Switzerland. We hypothesize that microbial diversity is increasing with distance from the glacier terminus and that both phototrophs and mineral weathering active heterotrophic bacteria are abundant.

Soil samples from different sampling sites ranging from the glacier terminus devoid of vegetation until 100 year old soils covered by a dense vegetation were taken. Microbial communities were studied with culture-independent molecular approaches such as genetic profiling and sequencing of clone libraries.

A high microbial diversity could be already found in the vicinity of the glacier terminus. Microbial diversity as expressed by the Shannon-Weaver diversity index was increased with distance from the glacier terminus. Both phototrophs and heterotrophic bacteria were abundant and their compositions were changing with distance from the glacier. Thus, a microbial succession from young to old soils is clearly visible and will now be investigated in more detail. Especially the driving forces and the mechanisms of carbon and nutrient acquisition during microbial succession will be evaluated.

Application fractal and multifractal methods to mapping prospectivity for metamorphosed sedimentary iron deposits using stream sediment geochemical data in eastern Hebei province, China

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The Eastern Hebei province, northern China has become the most important sources of iron mining industry in China and was chosen as a study area for mapping prospectivity for metamorphosed sedimentary iron deposits (MSID) using fractal and multifractal methods. The MSID mainly occurred within the ferrosilicon formations and were formed in the middle and late Archeozoic Era. The mineral assemblages associated with the Fe₂O₃ mineralization have high concentration values of Al₂O₃, Ti, V, Cr, Ni, Cu, Zn and Au. The multivariate statistical technique of principal component analysis (PCA) was used to delineate the comprehensive anomalous areas with the combined elements Fe₂O₃, Al₂O₃, Ti, V, Cr, Ni, Cu, Zn and Au using stream sediment geochemical data with the aid of GeoDAS[1]. The mapping singularity technique [2] was then used to identify the local anomalies from the first factor. The spectrum-area model (S-A) method [3] was then used to separate the anomaly from the singularity map. The results demonstrate that the local anomalies have high spatial correlation with the 103 known Fe deposits. The new anomalies should be further investigated for undiscovered Fe deposits.

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[3] Cheng, Q. et al. (2000) *Natural Resources Research* **9**,43-51.

New time constrains on brittle faulting in the core of the Lepontine dome, central European Alps

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Near-surface deformation related to neotectonics is typically accommodated by brittle faults, where localized displacement can result in the development of fault gouge composed of rock fragments and authigenic clays. A recent study reported initial results from dating gouge formation in the central European Alps [2], with samples from surface outcrop and a hydro-electric tunnel in the Simplon region of the central Alps.

Our new data originate from the AlpTransit tunnel, which provides a perfectly exposed section through the Penninic nappes of northern Ticino, Switzerland, crosscutting the core of the Lepontine metamorphic dome. The K-Ar age for the < 2 micron illite fraction from fault samples range between 7.1 and 9.5 Ma. The ages decrease with grain size, with the < 0.1 micron fraction ranging between 3.9 and 7.2 Ma. The ages are consistent with published apatite fission track ages of around 6 Ma from the vicinity of the sampled section (for example [1]), consistent with illite stability in fault gouges requiring temperatures slightly higher than those of the partial annealing zone for apatite. Fine-grained clay separates from the fault gouges consist of illite 2M1 and M2 polytypes, smectite and chlorite, with minor amounts of K feldspar impurity. The measured K-Ar ages are quite constant throughout and do not correlate with amount of K feldspar impurity. This suggests that the very fine grained cataclastic feldspar grains have isotopically reequilibrated due to fluid-rock interaction within the fault zone.

[1] Wagner, G.A. Reimer, G.M. & Jäger, E. (1977) Cooling ages derived by apatite fission-track, mica Rb-Sr and K-Ar dating: the uplift and cooling history of the Central Alps. Mem. Ist. Geol. Mineral. Univ. Padova 30, 27p. [2] Zwingmann, H. & Mancktelow, N. (2004) Timing of Alpine fault gouges. *EPSL*, **223**, 415-425.

REE-Y-Sc-Nb mineralization in the Strzegom-Sobótka granitic massif, Fore Sudetic Block, Poland: composition and evolution

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The late Variscan Strzegom-Sobótka Massif (SSM) occurs in the Fore Sudetic Block. It consists of four types of granitic rocks. All of them represent individual intrusions with different sources [1]. Pin *et al.* [2] reported an age of ca. 330-325 Ma for the one of them and 290 Ma for other types of granites on the basis of Rb-Sr whole-rock dating.

The studied Strzeblów biotite granodiorite of SSM is strongly altered. The mineral assemblage consists of albite, K-feldspar, micas, quartz and kaolinite. Decomposition of plagioclase, K-feldspar and biotite is related to strong albitization.

The rock contains accessory rare-element, REE,Y,Sc,Nb-rich mineralization. Monazite-(Ce), xenotime-(Y) and cheralite (~38 wt. % ThO₂, ~7 wt. % CaO) commonly form intergrowths with zircon. Hingganite-(Y) Y₂Be₂Si₂O₈(OH)₂, a member of gadolinite group, forms euhedral crystals with oscillatory zoning; it contains 30-36 wt. % Y₂O₃ and 15-23 wt. % of REE (La-Lu). Thortveitite (Sc₂Si₂O₇) forms subhedral crystals enriched in Y (≤16 wt. % Y₂O₃), Zr (≤5.7 wt. % ZrO₂) and Fe (≤4.4 wt. % FeO); a Fe²⁺Zr(Sc,Y,REE)₂ substitution is proposed. Sc,Ti-rich ixiolite is a principal Nb-Ta oxide phase; it contains ≤2.8 wt. % Sc₂O₃ and ≤8 wt. % TiO₂ but very low Ta (1-5 wt. % Ta₂O₅).

Textural and compositional features indicate magmatic origin of the rare-element minerals. However, post-magmatic to hydrothermal processes caused their partial alteration and recrystallization.

[1] Puziewicz (1990) *Arch. Min.* **XLV**, 1-2, 135-151. [2] Pin *et al.* (1989) *N. Jahrb. Miner. Abh.* **160**, 71-82.