

Evolution and Depositing Response During the Mesozoic and Cenozoic in Dunhua Basin, Northeastern China

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Dunhua Basin is located in the middle of Dunhua Mishan Graben in Northeastern China. And it is a rift-fault depression superposed basin which is controlled by the Dunhua Mishan fracture zone. A series of tectonic system transitions happens during the Mesozoic and Cenozoic period in the Dunhua Mishan fracture zone (Zhang et al., 1994; Yin ,1993; Li, 1994). The transitions starts in the Late Triassic. In the Late Jurassic, it is compressional; during the Cretaceous–Paleogene, it has a left-lateral displacement and a certain scale of extension; there is a compression in the late Paleogene, which then turns into the extension state again after Neogene. The evolution of Dunhua Mishan fracture zone plays a controlling role in the generation, development and evolution of the Dunhua basin. The evolution of the Dunhua Basin in the Mesozoic–Cenozoic period is: the compressional orogeny, strike slip & pull-apart and the initial rifting stage in Late Jurassic–Early Cretaceous (rift development stage); the inversion, uplifting and exhumation stage in Late Cretaceous–Paleocene; rift basin development stages in the Eocene–Oligocene period and Depression and basalt eruption stage after the Neogene. Different evolution stages have different deposition response characteristics.

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[2]Yin A, Nie S Y (1993). Tectonics, 1993, **Volume** 12: 801–813.

[3]Li ZX (1994). Geology, 1994, **Volume** 22: 739–742.

ANAMMOX ACTIVITY IN CONTAMINATED GROUNDWATER HAVING HIGH AMMONIUM AND NITRATE CONCENTRATIONS

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Abstract

Anaerobic ammonium oxidation (anammox) has been recognized as a critical process for removing nitrogen components in marine and surface aquatic systems, and recent studies suggest that anammox appears to be ubiquitous in natural and engineered environments. However, the activity and reaction rates of anammox in contaminated groundwater environments have never been directly quantified and their relative importance is still unknown. In our study, microcosm tracer incubation experiments with ¹⁵N-NH₄⁺, ¹⁵N-NO₃⁻, and ¹⁵N-NO₂⁻ were performed with groundwater and sediment samples from a contaminated aquitard near Elmira, Ontario, Canada, in order to measure the potential reaction rates and assess the respective contribution of anammox and denitrification activities. The tracer experiments showed that the potential anammox reaction rates ranged from 71.5 to 148.1 nmole N₂ L⁻¹ d⁻¹ which are very comparable to those reported in freshwater lakes. A comprehensive mathematical calculation suggested that 32 to 48% of N₂ production was attributed to anammox at the Elmira site. The measurements of NH₄⁺ and NO₃⁻ before and after incubation and elevated δ¹⁵N-NO₃⁻ indicated a complex and interactive ammonium attenuation mechanism including anammox and both microaerobic and anaerobic ammonium oxidation. Together with fluorescence *in situ* hybridization (FISH) results, our study points to anammox as an active process in the highly contaminated Elmira groundwater and to the fact that anammox organisms show a strong adaptability to heavy total nitrogen loads up to 46.5 mmol L⁻¹ and relatively high dissolved oxygen concentrations up to 65.3 μmol L⁻¹.

Pairing Re-Os systematics with geochemical proxies – environmental conditions and seawater chemistry

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Re-Os systematics of black shales provide depositional ages and syndepositional seawater ¹⁸⁷Os/¹⁸⁸Os ratios. The seawater Os-isotope record is a proxy for short-term changes in continental weathering rates. Additionally, both Re and Os are redox sensitive elements, and can be used with other redox sensitive trace metals to infer depositional conditions and seawater chemistry. Here we report Re-Os data, trace metal concentrations and sizes of pyrite framboids for Triassic black shale from Svalbard, Svalis Dome and Kong Karls Land across the Barents Shelf, spanning the Olenekian to early Carnian stages. Using these data, we discuss the evolution of Triassic environmental conditions.

Seawater ¹⁸⁷Os/¹⁸⁸Os ratios in the Barents Sea region decrease from ca 0.85 in the Olenekian to 0.65 in the late Ladinian and then increase to 0.73 in the early Carnian. These variations are synchronous with the decrease of ⁸⁷Sr/⁸⁶Sr ratios through the middle Triassic and a subsequent increase in the Carnian [1]. Decreasing Os and Sr isotope ratios reflect decreasing global continental weathering rates from Olenekian to late Ladinian.

Olenekian black shales from Svalbard and Svalis Dome have higher Mo contents for a given TOC content than younger late Anisian black shales. The decrease in [Mo]/TOC ratios suggests increasing restriction as the Panthalassa ocean retreated from Svalbard and Svalis Dome [2]. Olenekian black shales from Svalbard and Svalis Dome also have low Re/Mo and V/Mo ratios and small pyrite framboids, indicating euxinic conditions, whereas early Carnian shales from Kong Karls Land have low Mo contents and high Re/Mo and V/Mo ratios suggesting suboxic – oxic conditions.

In summary, from the Olenekian to the latest Ladinian in the Barents Sea region, continental input to the oceans decreased, and the depositional environment on the Barents shelf changed progressively from euxinic, deep, open marine to a shallow, water-restricted anoxic embayment.

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[1] Korte et al. (2003) *GCA* **177**, 47-62.

[2] Xu et al. (2009) *EPSL* **288**, 581-587.

Sweet Spot for the Formation of Sedimentary Dolomite

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8i. Interactions at the interface between organic components and minerals

The roles of organic matters in dolomitization were considered important, although their precise functions remain unclear. There are four proposed mechanisms for explaining the roles of organics and microbes in dolomitization: (1) Organic bounded Mg was released during decay of the organics; (2) extracellular polymeric substance may serve as nucleation sites; (3) Removal of sulphate (believed to be an inhibitor) through sulphate-reducing bacteria promotes dolomite crystallization, and (4) Oxidation of organics and proteins increases pH and alkalinity. However, laboratory experiments based on the proposed mechanisms failed to synthesize dolomite inorganically at room temperature. Mg²⁺ ions, which form one of the strongest bonds with water molecules among the divalent ions may only be partially dehydrated when incorporated into a growing nucleus of calcite or dolomite. The residual hydration sphere of the incorporated Mg²⁺ ions would then inhibit the further growth of the crystal. Dolomite crystals preferentially associated with organic rich layers / lamina in some partially dolomitized limestone and stromatolites. Early formed Mg-calcite or calcite crystals served nucleation sites for the dolomite. Synthesis experiments indicate polysaccharides in extracellular polymeric substance (EPS) of certain anaerobic bacteria can promote dolomite nucleation and growth. The polysaccharides adsorbed on surfaces of calcite or dolomite through hydrogen bonding with surface carbonate anions will lower the kinetic energy barrier for dehydration of metal complexes between H₂O and surface Mg²⁺. Author acknowledges supports from NSF and NASA Astrobiology Institute.

CO₂-rich fluids in lode gold deposits at the Sarekoubu- Qiaxia area, southern Altai, China

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Geological Setting

The Sarekoubu and Qiaxia lode gold deposits, located in the southern margin of Altai, occur in metamorphic volcano clastic rocks of the lower Devonian Kangbutiebao Formation (D₁k₂²) [1]. There are two groups of gold(copper)-bearing quartz veins(Fig.1): 1) lenticular or streaked quartz veins (QI) which are parallel to the foliated structure of the biotite-chlorite or garnet-chlorite schist; 2) sulfide quartz veins (QII) cutting across chlorite mica schist.

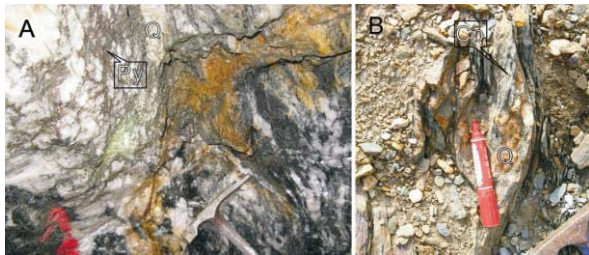


Figure 1: Au-Cu-quartz veins in the Sarekoubu and Qiaxia area

Fluid Inclusion Study

Carbonic fluid inclusions that are free of water are often found in the Sarekoubu deposit. They are of primary origin in QII veins, while a large number of these inclusions are of secondary origin in QI. There are two instances for T_{m,CO_2} and T_{h,CO_2} : 1) $T_{m,CO_2} = -60^\circ\text{C} \sim -56.5^\circ\text{C}$ and $T_{h,CO_2} = -23^\circ\text{C} \sim +31^\circ\text{C}$; 2) $T_{m,CO_2} < -57^\circ\text{C}$, to a minimum of -78.1°C , and $T_{h,CO_2} = -33.7^\circ\text{C} \sim -17.7^\circ\text{C}$. The $T_{h,TOT}$ of CO₂-H₂O fluid inclusions in vein quartz of the Sarekoubu deposit are 227~374 °C (QI) and 205~370 °C (QII). In this situation the lowest trapping pressures of CO₂-rich fluids can be estimated to be 110~ 300MPa based on CO₂ densities and CO₂ phase diagram at high *P-T* of Van den Kerkhof [2]. The ¹⁸O delta values of fluid inclusions in quartz are 7.54~11.84‰ (QI) and 3.82~7.82‰ (QII), whereas the D delta values are -84.7~98.2 ‰ (QI) and -75.8~108.8 ‰ (QII) respectively.

CO₂-H₂O fluid inclusions composed of a liquid CO₂ phase and a H₂O phase are commonly observed in the Qiaxia deposit. The melting temperatures of frozen CO₂ (T_{m,CO_2}) range from $-63 \sim -56.6^\circ\text{C}$ for QI, and from $-62.6 \sim -58.6^\circ\text{C}$ for QII; the homogenization temperatures of CO₂ (T_{h,CO_2}) = $19.6 \sim 28.9^\circ\text{C}$ for QI, and $25.2 \sim 27.9^\circ\text{C}$ for QII. The final homogenization temperatures ($T_{h,TOT}$) of these inclusions are mostly 180~380 °C (QI) and 180~360 °C (QII).

Conclusions

Gold and copper mineralization in the Sarekoubu and the Qiaxia area has a close relationship with CO₂-rich fluids and belongs to orogenic. The source of ore-forming fluids is related with regional metamorphism and associated magmatism.

[1] Xu *et al.* (2011) *Economic Geology* **106**, 145-158. [2] Van den Kerkhof & Thiéry (2001), *Lithos* **55**, 49-68.

Geochemical Characteristics of Heavy Metals in Water-Sediment Media in Panzihua V-Ti-Magnetite Zone, China

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Sulphide mines have always been the concerns of people because of their various forms and the resultant environmental problems, whereas oxide mines are paid less attention and not studied much because they do not cause obvious environmental problems such as acid mining drainage (AMD). However, the potential environmental problems caused by oxide mines can not be ignored.

The author chooses Panzihua V-Ti-Magnetite, a famous oxide mine in China, as the subject of research. In this thesis, the geochemical characteristics of heavy metals in water-sediment environmental media in the zone during the process of mining are systematically studied by using those media as research carriers and employing the analyzing methods of ICP-MS and ICP-OES. The research results are shown below:

The research on the geochemical characteristics of heavy metals in the system of water-suspended solid-sediment in the mining zone show that: the contents of heavy metals in water are very low, while those in suspended solids and sediments are relatively higher; the contents of Cu, Zn, Co, Ni, Fe and As in suspended solids are higher than those in sediments; the contents of Pb, V, Ti and Cr in sediments are higher than those in suspended solids. The partition coefficients show that: Hg is most active, As and Ni are less active, and Ti is least active. The morphological analyzing results of sediments show that in the sediments in Panzihua Mining Zone, Ti is most stable, V, Cu and Cr are relatively stable, and Zn, Mn, Co and Ni are more active. The index evaluation on potential ecological risk shows that most heavy metal elements in the sediments are contaminated, whether heavily or in a medium degree, in which Cu, Co, V and Ti are contaminated heavily or even more severely. The potential ecological risk index shows that all places are in light ecological risk and generally the potential ecological risk of heavy metals in the sediments are not high and they have limited influence on environment.