The role of Iron in the Nitrogen cycling in the early Earth: Insights from lab experiments

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Metallic iron (Fe) has been proposed to be an important factor for nitrogen (N) reduction in the early Earth to form NH_3 for the prelife organic matter [1]. In attempt to better understand the role of iron in the N cycling in the early Earth, we carried out lab experiments to investigate the behaviour of NH_3 and its N isotopic compositions at 300 – 700 °C and relatively low pressures (< 10 bars) with the existence of Fe. Under the experimental conditions, Fe was found to quickly (within minutes) react with NH_3 to form iron nitride and H_2. The release of N from iron nitride strongly depends on temperature, with quicker N_2 production at higher temperatures (e.g., minutes at 700 °C, hours at 500 °C, and no release of N_2 yet in a 10-day period at 300 °C). A kinetic (Rayleigh) N-isotope fractionation ($\alpha_{N2\text{-}Fe4N}$ = 0.977 ± 0.005; 1σ) was observed between the iron nitride and the released N_2, suggesting that the reverse reaction ($N_2 + 3H_2 \rightarrow 2NH_3$) was not significant. This implies that metallic Fe at sub-surface conditions intends to decompose rather than synthesize NH_3 even in a H_2 environment. Accordingly, our experimental results support a fast formation of N_2 in the early atmosphere and weaken the possibility that Fe plays a major role in the pathways of NH_3 production in the early Earth.

[1] Brandes *et al.* (1998) *Nature* **395**, 365-367.

Eruption stages and characters of volcanic rocks during upper Jurassic –early Cretaceous, Songliao Basin, China

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Considerable K/Ar isotopic dating data shows that there had three volcanic eruption stages during upper Jurassic – early Cretaceous in Songliao basin. The eruption ages were 158-146Myr, 130-122Myr and 119-113Myr. They were correspondence with the geological ages those were the second section of Huoshiling formation at Jurassic stage (J_3hsl), the first and the third sections of Yingcheng formation at Cretaceous stage (K_1yc and K_3yc).

By elements analysis for volcanic rocks and using the TAS plate [1] to identify the types of volcanic rocks in Songliao basin. Different types of volcanic rocks in different formation and at different volcanic eruption stages. Volcanic rocks in J_3hsl are mainly neutral-basic or basic such as basalt, andesite, dacite and few rhyolite etc. While, Volcanic rocks in K_1yc1 are mainly acidic such as rhyolite which is the most volcanic rocks type in K_1yc_1, dacite, necrolite, andesite and few mixpah, basalt. Volcanic rocks in K_1yc_1 are mixed. Neutral-basic or basic volcanic rocks appear in some wells while acidic volcanic rocks appear in others.

The distributions of the volcanic rocks being along to discordogenic faults indicate that volcanic rocks in Songliao basin are closely linked with discordogenic faults. The Most of the volcanic rocks in Songliao basin are in orogenic volcanic zone in diagram logτ -logσ proposed by A. Rittmann [2]. Frequent and intensive magma eruption and tectonic movement during upper Jurassic –early Cretaceous may be results of continental shell and lithosphere changing from compressional orogenesis into extension and thin to arise to the tectonic activization.

[1] LeMaitre (ed.) (1989) *A Classification of Igneous Rocks & Glossary of Terms*. Cambridge, UK, Cambridge University Press. [2] Rittmann & Sato (1973) *Philosophical Transactions of the Royal Society of London. Series A, Mathematical & Physical Sciences* **274**(1238), 5-16.