

## Constraints on water/rock ratio and solution pH of nepheline formation in chondrite parent bodies.

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Ca-Al-rich inclusions (CAIs) and chondrule mesostasis of carbonaceous chondrite contain secondary minerals such Nepheline ( $\text{NaAlSiO}_4$ ) and sodalite ( $\text{Na}_4\text{Al}_3\text{Si}_3\text{O}_{12}\text{Cl}$ ). These minerals are considered to be secondary altered minerals replaced by melilite or plagioclase. Although recent studies reported that the nepheline formation is correlated with hydro-thermal process on their parent body, its detailed condition is not yet established.

We conducted hydrothermal alteration experiments to understand the formation process of nepheline in chondrite parent bodies. As starting material, we prepared synthetic pure melilite (gehlenite, formula), mixture of melilite and  $\text{SiO}_2$ , plagioclase ( $\text{Na}_{0.5}\text{Ca}_{0.5}\text{Al}_{1.5}\text{Si}_{2.5}\text{O}_8$ ). Hydrothermal alteration experiments were performed with a PTFE reaction vessel loaded into steel autoclave. The experiments were carried out at temperature of 200 °C for run duration of 168 hours, with different pH condition (0, 7, 13, 14) and different water/rock ratios.  $\text{Na}^+$  concentration in all solution is maintained at 1 mol/l. We conducted also heating experiments. The experiments were performed at temperature of 500,600,700 and 800 °C for 24 hours with an electric furnace. We use run products of hydrothermal experiments as starting materials. After these experiments, run products were identified by powder X-ray diffraction (XRD) and scanning electron microscopy (SEM).

Under pH 14 conditions, products from gehlenite- $\text{SiO}_2$  and plagioclase were nepheline hydrate ( $\text{Na}_3\text{Al}_3\text{Si}_3\text{O}_{12}\text{H}_2\text{O}$ ) and analcime ( $\text{NaAlSi}_2\text{O}_6\text{H}_2\text{O}$ ), whereas at high water/rock ratios, these alteration didn't occurred. Under pH 14-7 conditions, Gehlenite alternated to hydro grossulor ( $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{1.53}(\text{OH})_{5.88}$ ). Under pH 13-7 conditions, analcime formed by replacing gehlenite or plagioclase. Under pH 0, no products formed from gehlenite and plagioclase, but gehlenite was dissolved. Under 500-700 °C conditions, we did not obtained from any products from analcime by heating experiments. Under 800 °C condition, analcime metamorphosed into amorphous material.

The results indicate that alteration of gehlenite and plagioclase dependent on the experimental conditions, pH and water/rock ratios. As far as we know, the results also indicate that concentration of ion in solution is related to form potassium rich hydrous mineral like nepheline hydrate and analcime. They suggest that in carbonaceous chondrite parent body aqueous alteration of gehlenite occurred under high pH and lower water/rock ration.

Keywords: nepheline, melilite, aqueous alteration, hydrothermal experiments, carbonaceous chondrite