

## Near-infrared spectroscopic determination of salinity and internal pressure of fluid inclusions in cuboid diamonds

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Diamonds are physically and chemically stable capsules that can carry hydrous components directly from the mantle. Studies of infrared spectra of diamonds with numerous micro-inclusions have shown the presence of water, carbonates and other minerals [1, 2]. Some inclusions preserve high internal pressures indicating that the original fluids and minerals were trapped during growth of host diamonds in the mantle [3, 4]. Infrared absorption spectra and Raman spectra of fluid and mineral inclusions are sensitive to the residual pressure. In principle, infrared absorption spectra of liquid water have potential to serve as a sensitive barometer for the residual pressures in fluid inclusions in diamonds. However, the extremely high absorption coefficient of water has avoided the application of infrared absorption spectroscopy to the pressure estimation of fluid inclusions in diamonds. In addition to the pressure estimation, vibrational spectroscopy is sensitive to the salinity of fluid and can give information on chemical composition of fluids in diamonds [5].

Recently, we have proposed a near-infrared (NIR) spectroscopic method to achieve the simultaneous determination of salinity and internal pressure of fluid inclusions in natural minerals including diamonds [6]. The use of NIR provides several advantages; NIR is transparent to various minerals including opaque minerals, no spectroscopic interference arises from minerals on the NIR absorption of hydrous fluid, etc.

In this study, a combination band between bending and stretching vibrations of molecular water at  $5180\text{ cm}^{-1}$  was observed for fluid inclusions in diamonds. Effects of salinity and fluid pressure on the spectral profiles were quantitatively investigated through laboratory calibrations. This method has been applied to fluid inclusions in natural diamonds with cubic growth habit (cuboid). The salinity and residual pressures were determined non-destructively.

[1] Chrenko *et al.* (1967) *Nature* **214**, 474-476.  
[2] Zedgenizov *et al.* (2004) *Min. Mag.* **68**, 61-73. [3] Navon *et al.* (1991) *Nature* **353**, 746-748. [4] Kagi *et al.* (2000) *Min. Mag.* **64**, 1057-1065. [5] Zedgenizov *et al.* *Min. Mag.* **70**, 219-229. [6] Kagi *et al.* (2006) *Appl. Spectrosc.* **60**, 430-436.

## Prebiotic polymerization of amino acids on the early Earth: Chemical evolution in the Hadean oceanic crusts

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Prebiotic polymerization of amino acids is the most fundamental reaction to promote the chemical evolution for origin of life. Many previous experiments favour high-pressure environments (>20 MPa) for polymerization of amino acids [1]. This leads to a new hypothesis that the first peptide may have formed in the Hadean oceanic crusts. Therefore, experiments simulating the crustal conditions were performed with various pressures (1~175 MPa) and temperatures (100~200°C) using autoclaves. Purified amino acid powders (100mg) of alanine, glycine, valine and aspartic acid were used in the present experiments without activating each amino acid or mixing with catalyses. The products were analyzed using HPLC and LC-MS.

Results indicate that: (1) glycine was polymerized up to 11-mer, which was not formed by previous experiments without catalyses; (2) valine was polymerized up to 3-mer; and (3) aspartic acid was polymerized up to 4-mer, accompanied with production of other amino acids. It is noteworthy that all examined polymerization reactions were promoted under high-pressure and water-poor conditions. Formation of by-products, such as melanoidines, was also controlled by pressure, increasing the effectiveness of polymerization of amino acids. Such situations would have happened inside of deep oceanic crusts of the early Earth.

[1] Ohara *et al.* (2007) *Ori. Life Evol. Bio.* **37**, 215-223.