Experimental determination of salinity of H_2O-CO_2-NaCl fluid inclusions

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Fluid inclusions that contain H_2O-CO_2-NaCl are common in many different geologic environments including hydrothermal ore deposits and medium- to high-grade metamorphic rocks. In gas-bearing inclusions a gas-hydrate is present at the temperature of ice-melting, precluding determination of salinity by freezing point depression. At the ice-melting temperature the gas-hydrate contains some H_2O, resulting in salinity estimated from ice melting temperatures that are higher then the actual salinity. At the present salinity of CO_2-bearing inclusions is determined by equations that use the final clathrate-melting temperatures in the inclusions and are valid only if melting occurs in the presence of CO_2-liquid, CO_2-vapor, and salt solution, or involves thermodynamic modelling of clathrate solid-solutions that are rather complicated and imprecise.

A technique that combines Raman microspectrometry and microthermometry has been developed to determine salinity of CO_2-bearing-aqueous fluid inclusions. The splitting of the Fermi diad in the Raman spectrum of CO_2 is density (pressure) dependent. A relationship between the Fermi diad splitting and density was determined using a high-pressure optical cell loaded with ultrahigh purity CO_2. This relationship was used to estimate the densities at the melting of the CO_2-hydrate phase in synthetic fluid inclusions with known CO_2 content. The CO_2 pressure in the inclusion at the clathrate melting temperature was calculated using the equation of state for CO_2.

Adding salt to the system produces a shift of the clathrate melting phase boundary to lower temperatures. The amount of the shift depends on the salinity: inclusions with higher salinity have clathrate melting at lower temperatures. The clathrate melting temperatures obtained by microthermometry and pressures at the clathrate melting point determined as described above have been used to develop an empirical relationship between the Fermi diad splitting and salinity using in synthetic fluid inclusions.

Geochronology constraints on sediment provenance and transport history in the Yangtze drainage basin

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Uplift of the Tibetan plateau and surrounding ranges and the subsequent climatic change cause complex reorganization of major rivers in Asia. Different patterns for drainage reorganization have been proposed. The evolution history of the Yangtze River has been extensively studied, but the timing of the Yangtze formation is quite controversial. Marine sediment, especially through using single-grained detrital geochronology techniques, may make a finer contraint on the history of Yangtze drainage evolution coupled with tectonic and climate changes.

In this study, thermochronologic data were collected from river sediments in the Yangtze delta at three horizontal layers, which represented modern, mid-Holocene and Last Glacial Maxium (LGM) deposition, respectively. Fission track (FT) dating of apatites show three distinct age populations at 3.5-4.0 Ma, 35.7-40.7 Ma, and 92.8-99.6 Ma. The youngest grains are indicated from the upper-reach mountainous area with higher exhumation rate, while the oldest grains are eroded from the lower-reach peneplain. The percentage of the youngest grains increase from 11.11% in the LGM detaic deposit to 35.71% in the mid-Holocene detaic deposit, indicating climate change over glacial-interglacial cycle exert great influence on sediment production and transport. This is further proofed by U-Pb zircon age data. Dominance of Proterozoic grains in Mid-Holocene detaic deposit is obviously different from LGM detaic deposit dominated by Paleozoic and Mesozoic grains. U-Pb age spectra of zircon donot bracket any <50 Ma grains (over 373 dated grains) which fingerprint the Tibet-Plateau source. Older zircon is difficult to assign to a specific source within a large drainage basin like the Yangtze, simply based on comparision between river zircon ages and basement ages. More detailed provenance conclusion can be reached by combination of age modes and trace elemental composition of detrital zircon.