

Trace element characteristics of hydrothermal titanite from iron-oxide-Cu-Au (IOCG) mineralization

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Hydrothermal titanite is a common accessory mineral in the alkali-chloride alteration assemblages accompanying iron oxide-Cu-Au (IOCG) mineralization. Sensitive High Resolution Ion Microprobe-Reverse Geometry (SHRIMP-RG) trace element analyses of titanite from a suite of worldwide IOCG deposits of diverse age and host rock composition have several distinctive features that differentiate these metasomatic titanites from those of associated igneous or metamorphic origins. The most notable difference is in the relative distribution of the rare earth elements (REE). Regardless of host rock composition, the IOCG metasomatic titanite is notably enriched in the light REE, peaking at La (sometimes Ce), with values up to 20,000 times chondrite in some cases. Magmatic titanite from typical metaluminous granitoid compositions is also light REE-enriched, but peaks at Pr or Nd (somewhat less commonly at Ce and rarely at Sm), having values as high as about 12,000 times chondrite. A distinct but less widespread REE pattern observed in some IOCG titanite grains is represented by a marked middle REE enrichment peaking at Sm, Gd or possibly Eu, to about 8,000 times chondrite. This latter REE pattern is attributed to a later hydrothermal or metamorphic growth when the light REE are no longer available. In titanite from both magmatic and metasomatic systems, Eu anomalies (Eu/Eu*) may be positive or negative, although within a given sample set, particularly among analyses with overall higher REE concentrations, negative Eu anomalies tend to dominate. In addition to differences in REE abundances and patterns, other trace elements may also be distinctive in metasomatic IOCG titanite, and may indeed provide complementary petrogenetic information. Whereas the generally similar REE patterns appear to be largely a function of fluid chemistry, greater variability in trace transition metals such as Sc, V and Cr demonstrates a more significant dependence on the composition of the rock column through which the mineralizing fluids passed.

Sediment pore fluid geochemistry from Krishna-Godavari basin (Bay of Bengal): Possible influence of methane hydrate occurrences

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Seismic data show regional presence of gas hydrate manifested in the form of Bottom Simulating Reflector (BSR) in the K-G Basin [1]. Drilling and logging activities on-board JOIDES Resolution in the Indian margin under the aegis of Indian National Gas Hydrate Program confirmed the existence of massive gas hydrate deposits in the K-G Basin [2]. K-G basin is a peri-cratonic rift basin located in the middle of the eastern continental margin of India. The study areas lie within the continental slope region. Recently large number of long cores (25-50 m) were collected on board *Marian Dufresne* (MD-161: May, 2007) using a Giant Callypso piston corer over a water depth range of 650-1600 m from K-G Basin Core locations were selected based on sub-bottom profiler (SBP) data. Cores have been collected under various geological environment viz., mud diapirs, mass flows, and hemipelagic sediments. Sulfate and C1-C3 hydrocarbon, chloride concentrations, total carbonate alkalinity, and carbon stable isotope ratios of CH₄ and CO₂ have been measured in several cores. The depth of sulfate-methane interface (SMI) from the sediment surface varies from 5 to 19m. Three sulfate concentration profiles have been recorded, viz., concave up with high gradient, sigmoidal and kink types. δ¹³C of CH₄ (as low as -110‰) and C1/C2+C3 ratios (as high as 4193) below the SMI are typical for biogenic hydrocarbon gases. The SMI is a zone of intense methane oxidation mediated by anaerobic methane oxidizing archaea. In one of the cores we have recorded thick beds of authigenic carbonates with δ¹³C values ranging from -41 to -52‰ VPDB possibly suggesting a paleo methane venting location. Instability of hydrate layers and fluctuation in vertical methane flux has happened in KG basin through geologic past. Multidisciplinary investigation is carried out to understand the geological conditions favourable for hydrate formation.

[1] Ramana *et al.* (2006) *Current Science* **91**. [2] Petroviev **1**, 5-10.