

SEM-EDS applications in mineralogical phases study of oil well cements attacked with H₂S/CO₂ mixtures

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Ordinary Portland cement (OPC) is the main component in cementitious materials used in oil wells construction. The mineralogical changes caused by chemical interactions between this material and acid gases (H₂S and CO₂), has been studied [1, 2]. The behavior of some mineralogical species, that constitute the main OPC phases, can indicate the integrity of this material in terms of compressive strength. Particularly, Ca(OH)₂ transformation in CaCO₃ caused by carbonation process. This study shows the influence of gas mixtures, at different pH₂S/pCO₂ ratios, on the chemical, mineralogical and mechanical properties of cement samples (class G and H) exposed to high pressure (total pressure = 1500 psi) and temperature (160°C) in well bore real conditions, based on the exposure time (t = 20, 40 and 80 days). In-closed system conditions (Parr reactor type), partial pressure of pCO₂ = 38 atm, and pH₂S = 4, 8 and 16 atm, for 0.1, 0.2 and 0.4 pH₂S/pCO₂ ratio, were used in this work. Mineralogical phases composition was determined by X-Ray diffraction, and scanning electron microscope and energy dispersive spectrometer (SEM-EDS). These techniques can be used to track resulting changes in the cementitious material microstructure (i. e. porosity) as intensity of carbonation, and estimates can be made of possible effects that these changes may have on the performance of the cementitious material. Compressive strength measurements were made after controlled time exposures. The results indicate important changes in mineralogy. The most important H₂S effect is test tube leaching. CaCO₃ formation (vaterite, aragonite and calcite) is the principal effect of CO₂. Both processes affect cementitious materials integrity. For pH₂S/pCO₂ ratios around 0.2, the maximum value of compressive strength is reached. In conclusion, an important relationship between the compressive strength and the pH₂S/pCO₂ quotient was determined, therefore, the integrity of cementitious materials can be estimated according to previous parameters.

[1] Centeno, *et al.* (2005) *GCA* **69**, 10. [2] Centeno (2007) Doctoral Lecture UCV, Caracas, Venezuela.

Determination of source and transfer-time of river sediments in alluvial plain from U-series nuclides: Evidence from the Ganges River System

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²³⁸U-²³⁴U-²³⁰Th radioactive disequilibria were analysed in different granulometric fractions of Himalayan sediments from the Ganges river and one of its main tributary: the Narayani-Gandak river. Such a study was performed by taking advantage of the natural mineralogical sorting done by the river, that is by analysing coarse and suspended sediments collected at different depths of the water column.

The results highlight that U-series disequilibria of river sediments carried by the different rivers depend both on their grain size and on their location in the basin. This dependence is explained by a mixing scenario between a coarse sedimentary end-member and a fine-grained one, which transit with different time constant within the alluvial plain. The river coarse sediments are Himalayan sediments, which transit rather slowly through the plain (>100ky) due to long period of storage driven by avulsion processes, and are modified by chemical weathering and pedogenetic processes within the alluvial plain [1]. By contrast, the fine-grained end-member of the suspended materials is marked by recent U-Th fractionations processes most likely occurring in plain soil horizons, which could indicate a much more fast transfer for this fine sedimentary end-member from the high range to the Bay of Bengal.

These results highlight that sediment U-Th characteristics are strongly size-dependent, outlining therefore that studying the whole granulometric fractions of the sediments is of prime importance for a correct use of the U-Th disequilibria to perform mass balance calculations and to assess the steady-state nature of erosion at the scale of a watershed.

[1] Granet *et al.* (2007) *Earth and Planetary Science Letters* **261**, 389-406.