The microbial role in diagenetic dolomite formation

DANIEL A. PETRASH[1*] AND KURT O. KONHAUSER[1]

[1]University of Alberta, Edmonton, Canada, petrash@ualberta.ca (* presenting author)

In the Neogene, the presence of extensive dolomite intervals exhibiting multigenetic crystal morphologies, distinctive $\delta^{13}C$ signatures and variable concentrations of Fe and Mn, strongly suggest the involvement of various microbial heterotrophic pathways in both dolomite nucleation and ageing [1,2]. However, the relevance of enhanced organic burial, and the catalytic role of microbes in post-depositional dolomite formation, and as an overall control of the Cenozoic abundance of dolomite, remains to be demonstrated.

Most recently, the anaerobic oxidation of methane (AOM), typically by a consortium involving archaea and sulfate reducer bacteria, has been found to be a significant geochemical process in marine sediments [3,4,5]. The activity of microbial communities capable of AOM is usually recorded by a distinctively depleted ^{13}C signal in their carbonate by-products [3]. However, in diffusion-dominated sediments more positive $\delta^{13}C$ could be the result of an admixture of methanogenic $^{13}CO_2$, or alternatively from extensive AOM, which may also increase the residual carbon pool in ^{13}C [5]. In Neogene sequences, the occurrence of multigenic dolomite-rich intervals with $\delta^{13}C$ varying from markedly negative to positive values points to AOM as a likely mechanism of ageing, and potentially extends the microbial dolomite induction zone a few hundred meters below the sediment water interface [e.g., ref. 4].

To fully understand the burial diagenetic history of such intervals, and by extrapolation, their ancient analogues, a comprehensive analytical approach is required. For instance, in addition to the possible presence of ^{13}C-depleted lipid biomarkers [3], when compared with their near-surface precursors dolomite cements formed under the influence of syntrophic AOM should exhibit relatively higher Fe, Mn, and probably bioactive Ni, Zn and Cu concentrations [6]. Unravelling the role of AOM in dolomite formation during burial into the methanogenic zone may provide new insights into the long-standing dolomite problem.

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Simulating fluoride evolution in groundwater using a reactive multicomponent transient transport model

PETTENATI MARIE[1*], PERRIN JEROME[1,2], PAUWELS HÉLÈNE[1], AND SHAKEEL AHMED[2,3]

[1]BRGM, Avenue Claude Guillemin, BP 36009, 45060 Orléans Cedex 02, France, m.pettenati@brgm.fr (* presenting author)
[2]IFCGR, Indo-French Center for Ground Water Research, NGRI, Uppal Road, 500 007 Hyderabad, India
[3]NGRI, Uppal Road, 500 007 Hyderabad, India

Overexploitation of crystalline aquifers in a semi-arid climate leads to a degradation of water quality. The Maheshwaram watershed is a typical Southern India rural watershed, with intensive groundwater abstraction (more than 700 productive irrigation wells), and a predominant paddy field cropping pattern [1-2]. We outline the process of F accumulation in this small endorheic watershed [3] where the groundwater has a high fluoride concentration of up to 4 mg l^{-1} (WHO guideline value <1.5 mg l^{-1}). The main processes responsible for the observed salt loads are probably being due mainly to irrigation return flow (IRF) and a high evaporation rate [4].

A solute recycling model that includes water/rock interactions and climatic parameters was used to assess the processes controlling fluoride contamination in a crystalline aquifer intensively exploited for paddy field irrigation. we used a 1D PHREEQC reactive-transport column [5] to conceptualize the infiltration of paddy field IRF under watershed-scale evaporation conditions.

Increase of F^- in IRF caused by evaporation and mineral dissolution (no fertilizer input) leads to the accumulation of F- in the aquifer. Crystalline aquifer overexploitation in semi-arid areas enhances geogenic pollution derived from the dissolution of fluoride-bearing minerals (fluorapatite, allanite, biotite) through a combination of complex hydrochemical processes [6]. The present model aims to provide a robust method for the development of prediction tools dedicated to aquifer management in this specific context.

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