



Mineralogical sources of groundwater fluoride in Archaen bedrock/regolith aquifers: mass balances from the Peninsular Granite Complex, southern India

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Fluoride in groundwater-sourced drinking water is a widespread concern in India, particularly in the granitic gneiss bedrock/regolith catchments of Andhra Pradesh, one of the most severely affected states. Mobilisation of F⁻ to groundwater is ultimately the consequence of bedrock weathering and regolith development, yet in crystalline bedrock/regolith terrain of the Peninsular Granite Complex, which constitutes a strategically important aquifer environment in India, uncertainties persist in relation to the relative contribution of the different F-bearing minerals and their distribution between the bedrock and the regolith. Even the relative significance of the bedrock and regolith as sources of fluoride to groundwater is disputed, as are explanations of seasonal and/or secular trends in groundwater F⁻. There are important implications for management of the groundwater resource. Understanding the mechanisms and progress of chemical weathering of the granitic gneiss is key to these questions, ie how effectively is F removed from its primary source(s) as the bedrock weathers? And, to what extent is F⁻ flushed from the weathering profile and/or re-sequestered by secondary mineral phases as the regolith develops? To address these questions we have applied optical petrography, XRD, scanning electron microprobe analysis, whole-rock chemical analysis and leaching experiments to samples of bedrock and regolith from two catchments in Andhra Pradesh. We have quantified the distribution of F between its individual mineralogical sources, and between bedrock and regolith. Experiments show there is no straightforward relationship between whole-rock F content and leached [F⁻]; in some instances regolith samples leach higher F⁻ concentrations than the fresh granitic gneiss. Results shed light on conflicting conceptual models of F release to groundwater in gneissic bedrock/regolith aquifers. Accounting for groundwater [F⁻], simple estimates of groundwater flux in the catchments suggest that the extant regolith in Andhra Pradesh has developed over a period of c.350 ka, during which time >70% of the original bedrock F has been removed by chemical weathering.