Imaging nanoparticle transport with magnetic resonance imaging

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While most renowned for its use in medicine, magnetic resonance imaging (MRI) has tremendous potential in the study of environmental processes. Its ability to non-invasively image inside materials that are opaque to other imaging methods is a particular strength. MRI has already been used, for example, to study fluid flow in rocks and image mass transport and biogeochemical processes in biofilms [1-4]. Here, we report on the application of MRI to image nanoparticle transport through porous geologic media. Commercially available paramagnetically tagged nanoparticles are used; the paramagnetic tag making the nanoparticle visible to MRI. In this study, packed columns of quartz or marble based gravels or sands were first imaged to check their suitability for MR imaging. The paramagnetic nanoparticle GadoCELL*Track* (BioPAL), was then prepared and pumped through the sand/gravel column. MR images were collected as the nanoparticle solution was transported through the system. These images can be calibrated to provide fully quantitative maps of nanoparticle concentration at regular time intervals throughout the column. Such data can be used to help develop models of nanoparticulate transport.

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Geochemistry, Sr-Nd isotope abundances and magnetic studies in some Deccan basalts and their bearing on mixing processes

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The Deccan Volcanic Province predominantly consists of tholeiitic flows and dykes. The flows attain a thickness of about 1.2 km in the western part but the thickness decreases towards east. The mafic dyke swarms occur in abundance in the western, central and northern parts of the volcanic province. The dykes are medium to coarse grained, porphyritic with phenocrysts of clinopyroxene (Wo_{31-39} Fs_{14-25} En_{42-46}), plagioclase (An $_{43-78}$) set in a groundmass of clinopyroxene ($Wo_{28-39}Fs21\text{-}54En_{17-39}$), plagioclase (An $_{63-65}$), olivine and opaque minerals.

We present new isotope data (Nd, Sr) and other geochemical data on some mafic dykes from the easternmost part of Deccan Volcanic Province (DVP).The mafic dykes have a restricted composition in the basaltic field. Because of restricted composition, it is difficult to relate the flows to the dykes. The rare earth element abundances of the dykes are similar to some important dyke swarms of the western part and the eastern dykes. The elemental abundances of some incompatible elements and a weak Eu anomaly suggest fractionation-induced effects. Initial $^{87}Sr/^{86}Sr$ ratios in the mafic dykes vary from 0.704625 to 0.806359 and $^{143}Nd/^{144}Nd$ varies from 0.512629 to 0.513382. The εNd values of the dykes are positive varying from +1.46 to +16.1. The Sr, Nd isotopic data do not conform to any of the fields established for the Deccan stratigraphic formations of the Western Ghats, but form a flat array in a $^{87}Sr/^{86}Sr$ vs εNd plot. The high Sr and Nd isotopic ratios of the dykes, perhaps accentuated during long distance magma migration, require complex contamination of a depleted source with an unusual enriched crustal component. Magnetic susceptibility and IRM measurements revealed that titano-magnetite was the major magnetic mineral in the samples. Detailed AF and thermal demagnetizations on oriented samples yielded ChRM directions which were similar to those of the Deccan super Pole.