# Origin of the acidic rocks of the Early Permian Panjal Traps, Kashmir, India

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**Abstract**

The Panjal Traps of northern India represent a significant outpouring of mafic and felsic volcanic rocks during the Early Permian and are synchronous with the opening of the Neotethys Ocean. Previous studies have suggested that the felsic volcanic rocks are derived by differentiation of mafic magmas. Dacites and rhyolites collected from the lower-middle portion of the volcanic pile near Pampore, Kashmir are peraluminous (ANCK > 1.0) in composition. Their whole rock $I_{Sr}$ values are variable ($I_{Sr}$ = 0.69307 to 0.71825) and indicate open system behavior of either Rb or Sr or both whereas their Nd isotopic compositions ($\varepsilon Nd_{(T)}$ = -8.6 to -8.9) are nearly uniform. The $\varepsilon Nd_{(T)}$ values and trace element ($Th/Nb_{PM}$ > 4; Nb/U < 10; Th/Ta > 8) ratios suggest the rocks are derived from the crust. Major and trace elemental modeling suggest the likely source was from the middle crust rather than the lower or upper crust. Furthermore, the felsic Panjal Traps have trace element compositions similar to some felsic volcanic rocks and A-type granitic rocks from other large igneous provinces (e.g. Karoo, Parana and CAMP) and that they were likely derived by partial melting of an ancient crustal (i.e. $T_{DM}$ = 1836 to 1937 Ma) source which experienced multiple episodes of crustal recycling. In contrast to other LIP felsic volcanic rocks, the acidic Panjal Traps are unique in that they were not derived from a mafic mantle source material. The heat required to melt the crust was likely due to the continuous injection of contemporaneous basaltic magmas which formed the majority of the mafic Panjal Traps.

# Biogeochemistry Improves Prediction of Metal Bioaccessibility of Yard Soils in Tar Creek, USA

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## Introduction

Heavy metal contamination in soils is ubiquitously observed due to mining, smelting, and industrial processes. Current approaches to determine the risk of metals via oral ingestion from soils are through operationally defined in-vivo or in-vitro tests. In addition, regulatory agencies often assume a default value as the bioavailable proportion of total metal. However, metal bioavailability in soil varies greatly based on their chemical forms, retention and releasing process, as well as exposure pathways. In order to better assess risks, it is necessary to bridge the gap between geochemistry, bioaccessibility and risk assessment of metals.

## Method

In-vitro simple bioaccessibility extraction tests (SBET) and sequential extractions were conducted on yard soil samples collected from the Tar Creek Superfund Site, OK, a former lead and zinc mining area. In addition, we conducted SBET and sequential extraction on pure phase metal minerals and metal minerals spiked in a reference soil to determine the role of both speciation and soil matrix effects on metal bioaccessibility. X-ray absorption spectroscopy techniques were also used as a supplementary tool on a subset of yard soil samples. We applied statistic models to predict metal bioaccessibility in soils given metal distribution in the soil matrix.

## Conclusion

Sequential extraction enables one to identify direct and potential hazardous metal fractions in soil in terms of being bioaccessible. Compared with total metal content, taking into account metal speciation in soil improves the estimation of the extent of bioaccessibility to different extents for different metals (Pb, Mn, Zn, Cd, Cu). The results help figure out the profound effects of mineralogical composition of metals, soil properties and particle size on determining metal bioaccessibility. Based on the results, site-specific metal biogeochemistry information might be able to be utilized to make metal bioavailability assessment more accurate.