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# Experiments to Investigate the Contribution of Silicate Weathering to the Dissolution of Himalayan Rocks

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Modelling of strontium budgets in the Alaknanda river, a headwater of the Ganges, has shown that the rapidly eroding High Himalayan Crystalline Series rocks make a significant contribution to the dissolved Sr flux. These rocks are carbonate-poor and flux calculations require that much of the Sr is derived from weathering of silicate minerals. This contradicts geochemical and isotopic modelling of stream water compositions in the Nanga Parbat massif which are interpreted to imply that 70 to 80% of the Sr is derived from trace carbonate.

We report results of leaching experiments on powders of reference materials and Higher Himalayan Crystalline Series rocks designed to quantify the significance of carbonate dissolution from these rocks. Samples of rock powder were treated with aqueous ammonium nitrate to remove exchangeable strontium followed by leaching in an ammonium acetate buffer to leach carbonate minerals. A small amount of strontium was removed from the carbonate samples by exchange and the remaining carbonate dissolved in the ammonium acetate buffer. Complete dissolution was achieved in 14 days for calcite and 49 days for dolomite. In the case of silicate rocks trace amounts of carbonate were observed by cathodoluminescence and these were expected to dissolve in the ammonium acetate buffer. However, there was a disproportionately large contribution to the total dissolved strontium from the exchange fluid. It was further noted that while the $^{87}$Sr/$^{86}$Sr ratio for exchanged and leached carbonate was consistent with the bulk $^{87}$Sr/$^{86}$Sr for carbonate materials, for silicate materials it was lower in the exchange solution than in subsequent leaching stages. The silicate residue from leaching had an elevated $^{87}$Sr/$^{86}$Sr demonstrating that incongruent dissolution of strontium had occurred. Minerals that may exchange strontium in this way are feldspar and mica. An experiment on a mica separate demonstrated that there is indeed strontium removed from it by exchange and leaching. Further experiments will examine the behaviour of plagioclase feldspar. Incongruent dissolution is expected to occur as a result of the fresh exposure of silicate mineral surfaces. In this case $^{86}$Sr, which occupies different sites to $^{87}$Sr, is preferentially leached. In the High Himalayas river gradients are steep and erosion is rapid. Thus, the removal of strontium from freshly broken grains can be a mechanism for the large contribution to the strontium budget observed in this area.

Incongruent dissolution may occur either as a result of the fresh exposure of silicate mineral surfaces where $^{87}$Sr, produced by $^{87}$Rb decay, occupies different crystallographic sites than $^{86}$Sr or because minerals with different Rb/Sr ratios and therefore different $^{87}$Sr/$^{86}$Sr ratios dissolve at different rates. In the High Himalayas river gradients are steep, erosion is rapid and the rocks comprise low Rb/Sr feldspars and medium to high Rb/Sr micas. Since High Himalayan Crystalline rocks typically have a high $^{87}$Sr/$^{86}$Sr (around 0.9), removal of strontium from these rocks, even where $^{87}$Sr/$^{86}$Sr is depressed by incongruent dissolution, can contribute to the elevated $^{87}$Sr/$^{86}$Sr values determined from the Alaknanda River (0.723).