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# The Effect of Lesser Himalayan Calc-Silicates on the $^{87}Sr/^{86}Sr$ of the Bhote Kosi River of Nepal – Implications for Himalayan Weathering, the Marine $^{87}Sr/^{86}Sr$ Record and Global Climate

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During the last 40 Ma the marine $^{87}Sr/^{86}Sr$ record shows a rapid rise (from 0.7078 to 0.7092; Richter *et al*. 1992), a trend which has been linked to the high flux of Sr and high $^{87}Sr/^{86}Sr$ ratio of rivers draining the Himalayas (e.g. Palmer & Edmond, 1992). High weathering fluxes from the Himalayas may moderate long-term climate change if $^{87}Sr/^{86}Sr$ ratios are a measure of silicate weathering fluxes. However there is considerable dispute as to the relative flux of $^{87}Sr$ from carbonate rocks (which has no long-term impact on climate) versus that from silicate rocks. Here we report analyses of waters and bedrock from the Bhote Kosi river, which flows alongside the Friendship Highway for much of its length from a source in southern Tibet to its confluence with the Sun Kosi in central Nepal. The Bhote Kosi crosses the three main lithological groups of the Himalayas (Tibetan Sedimentary Series, High Himalayan Crystallines and Lesser Himalayas), providing an opportunity to gauge the influence of each group upon the dissolved load. There is a marked rise in $^{87}Sr/^{86}Sr$ ratios immediately downstream of the Main Central Thrust (MCT) and interest is focused upon the role of carbonate-rich lithologies exposed in this section. We have also analysed waters and rocks from the catchment of a second Nepalese river system, the Langtang Khola-Trisuli, which lacks carbonate lithologies, as a baseline indicator for the effect of Lesser Himalayan Series carbonates on the dissolved load of the Bhote Kosi.

The Sr systematics of the dissolved load are illustrated in Fig. 1. The most significant change in the downstream $^{87}Sr/^{86}Sr$ profile of the Bhote Kosi is the steep rise from ~0.73 to ~0.76 occurring south of the Main Central Thrust (MCT) which separates the carbonate poor rocks of the High Himalayan Crystalline Series from the underlying carbonate-rich lithologies of the Lesser Himalayas. Tributaries draining Lesser Himalayan carbonates and calc-silicates within this section have $^{87}Sr/^{86}Sr$ >0.8 and low Sr concentrations. The relationship of geology with cation abundances and isotopic ratios indicates that these features result from the dissolution of micaceous dolomites of the Midland Group rather than the input of hot springs or the dissolution of predominantly silicate-bearing rocks. In contrast, $^{87}Sr/^{86}Sr$ values for the Lesser Himalayan carbonate-free Langtang Khola baseline system never exceed 0.738.

Despite low Sr concentrations, the Lesser Himalayan carbonates of the Bhote Kosi catchment, which include both pure and impure dolomites, possess sufficiently high $^{87}Sr/^{86}Sr$ values (>0.77) to account for the noted increase in dissolved Sr isotope ratios, especially when the rapidity of the chemical weathering of carbonate-bearing rocks is considered. In a majority of cases, these $^{87}Sr/^{86}Sr$ values cannot be explained simply through radioactive decay, despite the great age of the rocks (2500-1800 Ma; Ahmad *et al*., 2000), implying that they have gained $^{87}Sr$ or lost Rb during their history. Exchange with silicate lithologies during metamorphism is one possible and logical explanation for this. The unusually low Sr concentrations of the Lesser Himalayan calc-silicates makes them candidates for the receipt of Sr through diffusive mechanisms.

The Bhote Kosi Lesser Himalayan calc-silicates and carbonates correlate with highly radiogenic carbonates in other parts of the Himalayas (Bunbury *et al*., 1999; Singh *et al*., 1998). The widespread distribution of radiogenic carbonates exposed throughout the Lesser Himalayas and the high dissolved $^{87}Sr/^{86}Sr$ of rivers draining these units is a potentially significant factor in the unusual Sr geochemistry of the Ganges-Brahmaputra system. If so, this suggests that much more care should be exacted when using the $^{87}Sr/^{86}Sr$ record as a proxy for Himalayan silicate weathering and $CO_2$ uptake from the atmosphere, and perhaps that the use of such a proxy is inappropriate.

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Keywords: weathering; strontium isotopes; Himalayan rivers; carbonates

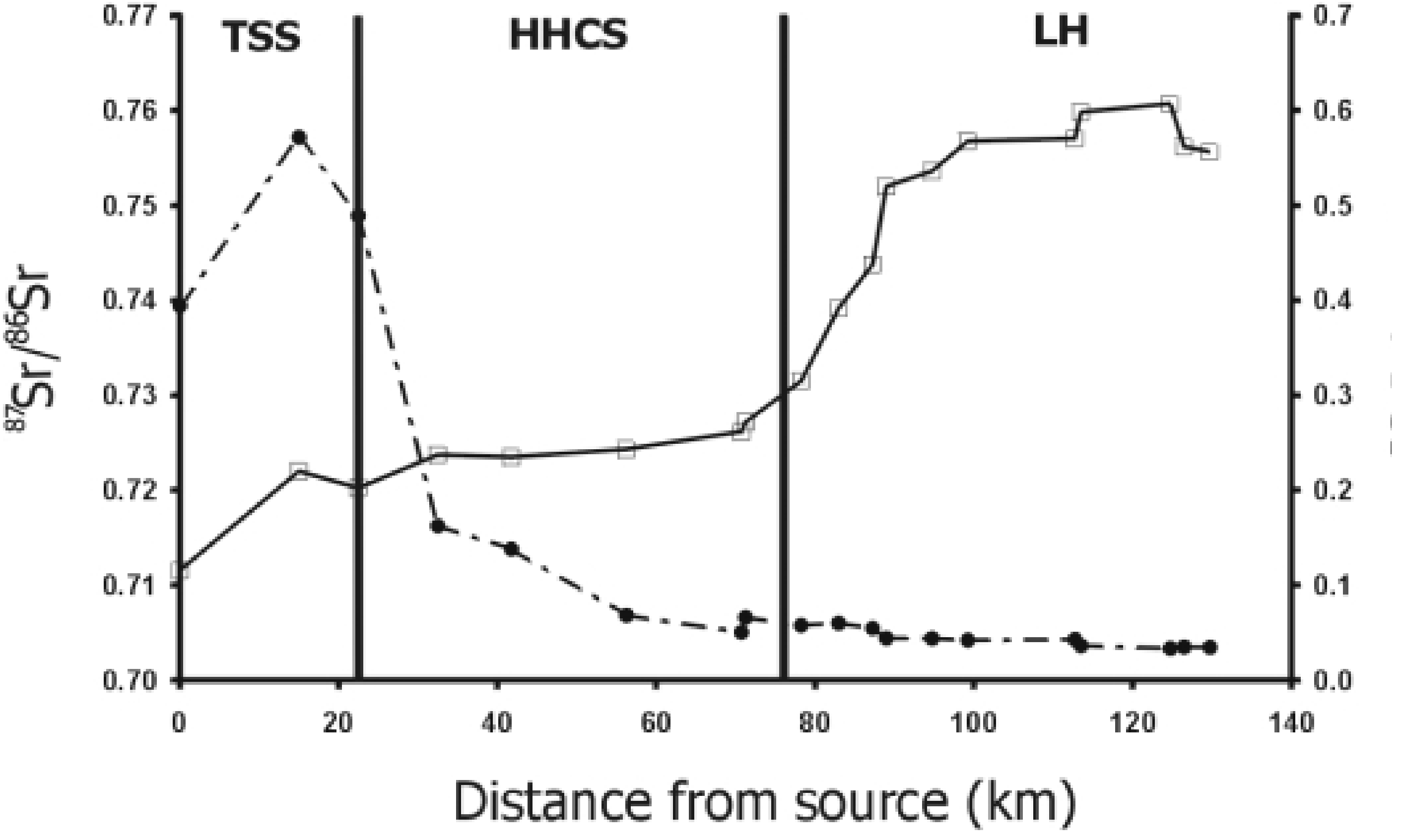

Fig. 1. Downstream changes in $^{87}Sr/^{86}Sr$ (squares) and Sr concentrations (circles)

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