Chemical evolution of a sheet-like magma body induced by compositional convection: The Nosappumisaki intrusion, Japan

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Fractionation in the interior of a closed system magma chamber caused by the injection of a fractionated melt produced in the peripheral boudary layer has been theoretically proposed (boudary layer fractionation; e.g. Lungmuir (1989)). The porcess is also advocated from a fractionation trend of the volcanic rocks (Kuritani (1998)), although Marsh (1995) argued that the "fractionation" in a small igneous body is mostly for due to separation of preexisiting "phenocrysts". To investigate if the boundary layer fractionation acutually occur in small intrusions, detailed vertical variation of a interstitial melt composition of a "phenocryst" rich igneous body was studied.

The Nosappumisaki intrusion in eastern Hokkaido is a Cretaceous shoshonite sill intruded into Cretaceous sedimentary rocks. "Phenocrysts" already present at the time of intrusion are concentrated in the bottom accumulation (cumulate) zone and are almost absent in the overlying middle zone. The intrusion consists mainly of these two zones, which are sandwiched between the marginal and the chilled zones.

The average interstitial melt composition in the sill is statistically the same as the melt composition at the time of intrusion estimated from the groundmass composition of the chilled zones. The interstitial melt composition shows an S- or flipped S-shaped vertical variation, and mafic components and compatible trace elements are rich in the lower part, and felsic components and incompatible trace elements are rich in the upper part. These facts indicate transfer of a fractionated melt from the cumulate zone to the overlying middle zone, thereby demonstrating that boundary layer fractionation actually took place in the Nosappumisaki intrusion. This is also suggested by disctribution of pipe-like stuctures and dissolution texture dound only in the cumulate zone.

A mass balance model that can treat the formation of fractionated melt and its migration in the sill was constructed. Comparison of the modeling results with the observed variation of the interstitial composition shows that the velocity of the downward growth of the upper solidification front must have been very slow in the early stage relative to the upward advance rate of the bottom solidification front. Noticeable drop in the liquidus and solidus temperatures may have suppressed the rate of downward growth of the upper solidification front due to the extensive injection of the fractionated liquid from the cumulate zone to the middle zone.

Sources of sediments to the Bay of Bengal during since 15 kyrs.

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The Ganga and Brahmaputra rivers are supplying enormous amount of sediment to the Bay of Bengal. In earlier studies it has been shown that bulk of the sediment to the Bay of Bengal are derived from the erosion of the Higher Himalaya and transported via the Ganga-Brahmaputra River System. Erosion in the Ganga-Brahmaputra are climatically and tectonically controlled. Further, the sediments of these two systems are isotopically different due to geological differences of the basins. In this study we studied the sources and the fluctuations (if any) of the sediment supply through these rivers by analysing Sr, Nd isotopic compositions of the sediment from the active channel levy of the Bay of Bengal from various depth which goes up to 15 Ky in the past.

Both Sr and Nd were measured in the silicate phase of the sediment. $^{87}Sr/^{86}Sr$ and ε_{Nd} of these sediments show a very narrow range, 0.73±1.0 and -15.5±0.5 respectively. From these data it is clear that the Himalaya has remained the major source of these sediments since last 15 ky and there does not seem to be any systematic difference among the sediments from various depths (or ages) (Fig. 1). The isotopic signatures of all the samples are almost constant with depth. This implies that over 15 ky time scale there has been no significant change in the mixing proportion between Ganga and Brahmaputra sediment discharge despite strong changes in the river's runoff. This may reflect parallel climatic changes over the two river basins. Alternatively, high the residence time of the sediments in the deltaic zone where mixing occurs tend to homogeneize high frequency changes.

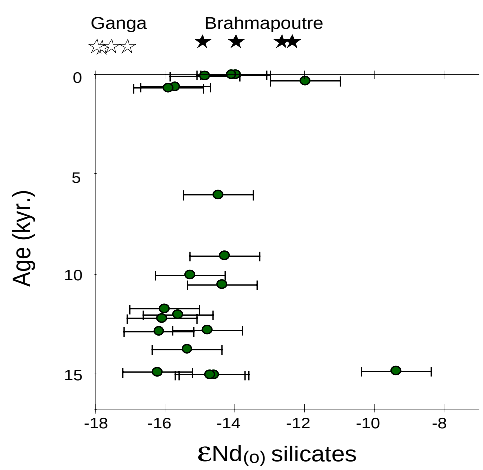

Fig. 1 Nd isotopic data on Bengal fan sediments and modern rivers sediments.