

Fe, Al and Ti variations in marine sediment: implications in provenance and paleoclimatic analyses

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Krishna-Godavari basin (K-G basin) is a pericratonic rift basin, formed during 130-134 Ma ago (lower cretaceous) as a consequence of rifting and subsequent drifting of India from the contiguous Antarctica–Australia land mass [1]. Krishna and Godavari are the major rivers that bring the sediment load to the K-G basin. 80% of the catchment area of Krishna river is occupied by Archean and younger crystalline rocks and the remaining 20% comprises of Tertiary Deccan traps (basaltic) and recent sediments [2]. The drainage basin of Godavari river includes Deccan traps (48%), Archean Granites (39%), Precambrian and Gondwana sedimentary rocks (11%) and recent alluvial cover (2%) [3]. Temporal variations in the Fe_T/Al ratio of a sediment core (MD161/8) from K-G basin indicate the relative contributions of terrestrial load from Deccan basalts and granitic rocks [4]. Good correlation ($r^2=0.673/0.74$) between Al/Ti and Fe/Ti suggest a common source and geochemical pathways for Fe_T and Al transportation and accumulation in the sediments [5]. Further studies (Sr-Nd isotope studies) are ongoing to quantify the relative contributions of Deccan basalts and Granitic rocks.

Variations in the Fe_{HR}/Fe_T (highly reactive iron/total iron) ratios normalized with respect to the source indicates the weathering/monsoon intensity. Fe_{HR}/Fe_T ratios are closely related to the runoff as high runoff results in increased content of poorly crystalline iron hydroxides/oxides in the suspended load which constitutes the Fe_{HR} content of the suspended particulates [6].

[1] Ramana *et al* (2001) *EPSL* **191**, 241-255. [2] Ramesh & Subramanian (1988) *JHyd* **98**, 53-65. [3] Biksham & Subramanian (1988) *JHyd* **85**, 515-524. [4] Peketi (2012) Ph.D thesis. [5] Latimer *et al* (2006) *Geology* **34**, 545. [6] Canfield (1997) *GCA* **61**, 3349-3365.

Experimental Evolution of Dissimilatory S Isotope Fractionation

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Sulfur isotope fractionation during microbial sulfate reduction is controlled by the energy metabolism of sulfate reducing microorganisms. While this metabolism responds to variability in the local environment, it is ultimately dependent on the underlying genotype. Since genotype and environment have both changed throughout Earth's history, the geological record of biogenic S isotopes reflects the influence of environmental and evolutionary change. However, the basic interplay between microbial evolution and S isotope fractionation has not been examined.

We investigated the evolutionary response of S isotope fractionation in *Desulfovibrio vulgaris* Hildenborough (DvH) and *Desulfomicrobium baculatum* (Dbac) through experimental evolution. Twelve replicate lines of DvH and three replicate lines of Dbac were serially transferred in batch cultures of defined media at 33°C. After 1000 generations, the descendant DvH strains were markedly more fit, with relative growth rates increasing by $\approx 20\%$. Fitness improvements were even more pronounced for descendant Dbac strains, with 300% enhancement in growth rates after only 200 generations. In both DvH and Dbac lines, the descendant strains have a clear selective advantage over their ancestors, and have undergone evolutionary adaptation to the constant environmental conditions of the experiment.

The ancestral cultures of DvH and Dbac produced sulfide depleted in $^{34}S/^{32}S$ relative to the sulfate of $-6.8\pm 1.0\text{‰}$ and $-15.4\pm 0.7\text{‰}$ respectively. When the assay was repeated on the evolved lines, Dbac reproducibly showed a lower $^{34}S/^{32}S$ fractionation of $-12.3\pm 0.4\text{‰}$ whereas DvH displayed the same fractionation as its ancestor. These observations suggest that evolutionary trajectory of S isotope fractionation correlates with the magnitude of evolutionary adaptation to a specific environment. As these evolutionary changes in the isotopic phenotype mimic, in a broad sense, known physiological responses of dissimilatory sulfate reducing bacteria, it may be possible to disentangle the metabolic and environmental histories imprinted in the S isotope record..