Isotopic variations in mafic volcanic rocks from the western branch of the East African Rift

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Isotopic variations in lavas from regions of low tectonic extension, such as the western branch of the East African Rift (EAR), can be used to probe regional variability in the underlying continental lithospheric mantle. Volcanic rocks from the western branch of the EAR are isotopically among the most extreme young samples on Earth. Pb, Hf, Nd and Sr isotope compositions for mafic, undersaturated alkalic lavas from Rungwe, Kivu, Virunga and Toro-Ankole all show large variations over short lateral distances, indicating extensive extension from a common mantle source beneath the western branch of the EAR, such as the lithosphere/asthenosphere boundary. In contrast, the distinct isotopic variations within each volcanic province extend away from Rungwe, Kivu, Virunga and Toro-Ankole all show large variations over short lateral distances, indicating extensive extension from a common mantle source beneath the western branch of the EAR, such as the lithosphere/asthenosphere boundary.

Electron shuttle production by Shewanella oneidensis

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Extracellular Respiration

Many dissimilatory metal reducing bacteria have evolved mechanisms to transfer electrons from the cytoplasmic membrane quinone pool to insoluble substrates (e.g. oxide minerals and electrodes) located beyond their outer membranes [1, 2]. Shewanella oneidensis strain MR-1 is the best understood model system for extracellular respiration. While biochemical evidence supports a direct mechanism for electron transfer to insoluble substrates, there is also strong physiological evidence for electron shuttling [3, 4]. Flavins (riboflavin and flavin mononucleotide (FMN)) were identified as the primary electron shuttle compounds produced by Shewanella. Our work seeks to define the contribution of electron shuttles to the reduction of insoluble substrates by S. oneidensis and understand the molecular mechanism underlying the production and processing of flavin shuttles produced by these bacteria.

Discussion of Results

We designed a mutagenesis screen in S. oneidensis to isolate strains that no longer accumulated flavins in culture supernatants. This work led to the identification of UshA, a 5'-nucleotidase involved in the processing of periplasmic flavin adenine dinucleotide (FAD) to FMN and adenosine monophosphate [5]. Strains defective in ushA accumulated FAD in culture supernatants instead of FMN or riboflavin. We repeated our mutagenesis screen in an ushA deletion mutant background to identify additional components involved in electron shuttle processing and secretion. This secondary screen identified mutants defective in flavin export and in electron shuttle processing. We designed a mutagenesis screen in S. oneidensis to isolate strains that no longer accumulated flavins in culture supernatants. This work led to the identification of UshA, a 5'-nucleotidase involved in the processing of periplasmic flavin adenine dinucleotide (FAD) to FMN and adenosine monophosphate [5]. Strains defective in ushA accumulated FAD in culture supernatants instead of FMN or riboflavin. We repeated our mutagenesis screen in an ushA deletion mutant background to identify additional components involved in electron shuttle processing. This secondary screen identified mutants defective in flavin export and in electron shuttle processing. We have generated the first strain of S. oneidensis that is fully defective in electron shuttle secretion, allowing us to conclude that electron shuttling accounts for ~75% of the electron transfer activity to insoluble substrates. Moreover, electron shuttling mutants have no defect in respiration of soluble electron acceptors or chelated iron.