HOT-WIRED: THE ROLE OF EXTRACELLULAR ELECTRON TRANSFER IN SUSTAINING PRIMARY PRODUCTION BY HYDROTHERMAL VENT MICROBES

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Introduction

Microbes have evolved a variety of metabolic strategies to flourish in the absence of oxygen (e.g. sulfate reduction, methanogenesis). Recent studies of extracellular electron transfer (or EET) have further expanded the repertoire of metabolic capacities that facilitate life in anaerobic environments. EET is a process whereby microbes shuttle charge to or from solid phase electron acceptors or donors. EET was first described in iron-reducing proteobacteria by Lovley and Philips (*1*), which use iron oxides as terminal electron acceptors for respiration. In recent years is has become apparent that EET is quite widespread, and studies have shown that a diversity of microbes are capable of EET, and that EET is coupled to an equally diverse number of metabolic modes.

Microbial EET at hydrothermal vents

At hydrothermal vents, EET may enable microbes in anaerobic milieus to remotely access dissolved oxidants in the overlying seawater through the semi-conductive metal sulfides cross redox gradients. Here we present laboratory and *in situ* experiments that support this hypothesis, revealing that hydrothermal vent microbes employ and depend upon EET to access spatially remote oxidants via semi-conductive pyrite. To simulate the physical and electrochemical conditions in vent sulfides, we constructed a two-chamber flow-through bioelectrochemical reactor in which a pyrite electrode was enclosed in one chamber and subject to simulated hydrothermal conditions. Substantial electroactive biofilms formed on pyrite in electrical continuity with oxygenated water. Phylogenetic and metagenomic analyses revealed a diversity of autotrophic and heterotrophic archaea and bacteria, markedly different in composition from the control (pyrite without electrical continuity). Stable carbon isotopic tracer experiments further reveal differences in carbon fixation among communities in and out of electrical continuity with oxygen. The data presented here reveal that microbial communities use conductive minerals such as pyrite to enable the reduction of spatially remote oxidants. Thus EET, by enabling sustained access to terminal electron acceptors while maintaining the functioning of strictly anaerobic metabolisms, may alleviate the limitation of oxidants commonly associated with anaerobic environs.

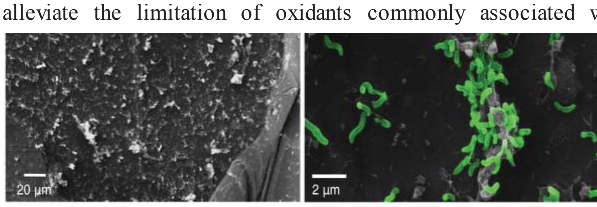

Figure #1: SEM image of electroactive biofilm, and SEM image with false color added to microbial cells to provide contrast.

[1] Lovley, D.R., and Phillips, E.J. (1988). *Appl. Environ. Microbiol.* **54**, 1472.

Subduction-related fluids influence on the Oligo-Miocene transitional magmatism of the Sulcis area (SW Sardinia, Italy)

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The Sardinia-Corsica microplate was involved in Oligo-Miocene times in a SE-ward drift and counterclockwise rotation from the European margin in western Mediterranean to its current position. This movement was caused by the roll-back play of a NW-ward subducting oceanic plate under this margin and produced the detachment of this microplate from the continental margin and the openning of the Liguro-Provençal basin. As a result of the subduction abundant calc-alkaline magmatism of orogenic affinity occurred, mostly in the western sectors of Sardinia. In the final stages of the Miocene subduction and magmatism, coinciding with an increase in extensional tectonics, in the Sulcis area magmatism shifted from typical orogenic andesites to more evolved products of transitional character, ranging from trachydacites to rhyolites, with the relevant presence of peralkaline magmas (comendites), which were emplaced mostly as widespread ignimbrites reaching up to 20 km^3 in volume and forming a pile over 200 m thick.

The present work is focused on the study of the evolved rocks of the Sulcis area. Literature was reviewed for data, and new sampling was done. Major and trace elements whole rock XRF and ICP (-OES and MS) analyses were done on over 200 new samples covering the whole sequence, as well as Sr, Nd and Pb isotopes on a selection of 26 samples. Mineral chemistry (EMP) was done on a selection of representative samples.

Trace elements and isotope ratios reveal that magmas were originated in a mantle wedge metasomatised by fluids released by the subducting slab which were both hydrous fluids from the oceanic crust and overlying sediments, and sediment partial melts. It is also evidenced that the mantle beneath Sardinia had an original EMI signature which was subsequently modifyed by the Central Atlantic Plume event in Cretaceous times (to get a more EAR-like signature) and finally by the subduction fluids. Isotopes show that fluid influence progressively decreased with time and that assimilation processes during magma evolution were scarce. The transitional character of this magmatism was caused by the increased extensional setting, which controlled magma alkalinity and favoured melting of mantle wedge sectors with less slab-released fluids. Magma evolution in the upper crust was dominated by fractional crystallisation of magmas with slightly different initial alkalinity, producing subparallel evolutionary trends. The peralkaline magmas were originated by the evolution of the more alkaline magmas, with participation of the plagioclase effect and the resorption of cumulate amphibole, which further favoured it.

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