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Carbon isotopic constraints on the metabolism of archaea inhabiting sulfate/methane transition zones in the deep subsurface

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We studied the isotopic compositions of live archaeal biomass inhabiting sulfate/methane transition zones in deeply buried sediments at the Peru margin (ODP Leg 201) to obtain information on carbon sources and metabolism of the archaeal community. The live biomass for isotopic analysis comprised both intact membrane lipids (IPLs) and cells detected by archaeal FISH probes. IPLs are particularly labile against hydrolytic cleavage of the polar headgroup and thus considered to be representative of live prokaryotes when found in environmental samples. The major IPLs detected were GDGTs (glyceroldialkylglyceroltetraether) with glycosidic headgroups representative of archaea. Structural features such as a calditol based tetraether and crenarchaeol indicate the presence of crenarchaeal community members. Surprisingly,

isotopic compositions of IPLs and intact archaeal cells (the latter determined by a combination FISH and secondary ion mass spectrometry) suggest that methane is not an important carbon source for these communities. Autotrophic carbon fixation appears unlikely given the observed relationships between isotopic compositions of DIC and archaeal biomass. Instead, the combined lines of isotopic evidence suggest that the bulk of the archaeal community is heterotrophic. Combined isotopic data from IPLs and whole cells provide novel information on the metabolism of uncultured archaea in deeply-buried sediments and raise the possibility that methane is oxidized without serving as the source as cell carbon.