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Stable isotopes evidencing microbial activity, mineral authigenesis and fluid mixing in deep interstitial fluids off South-Western Australia (IODP Leg 369)

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Interstitial waters extracted from long sediment cores retrieved during expedition 369 (Sites U1512-U1516) of the International Ocean Drilling Program (IODP) were analysed for the stable water isotopic (O and H isotopes) composition to constrain hydrographic changes in this region prior to modern time and possible changes due to water-rock interaction and fluid mixing. Dissolved sulfate (S and O isotopes), and sulfide (S isotopes) were analyzed to characterize, in concert with concentration measurements, diagenetic microbial and water-rock interaction processes in the sulfur cycles. The measurements demonstrate substantial downcore variations in the water oxygen isotope composition. Net microbial sulfate reduction with depth was observed at all sites, but sulfate was only found to be consumed completely, within the investigated core lengths at Site U1512, that is located off southern Australia. Whereas associated sulfur isotope fractionation is characteristic for medium range fractionation factors, the oxygen isotope composition provides evidence for a much more complex story of sulfur diagenesis at the investigated sites: At Site U1516, for instance, the oxygen isotope composition of dissolved sulfate is equilibrated with pore water, although sulfate concentrations remain above 20 mM. This indicates an intense re-oxidative sulfur cycle. At Site U1513, on the other hand, the oxygen isotope composition remains out of isotope exchange equilibrium although sulfate concentrations fall below 20 mM, indicating that the net decrease in dissolved sulfate is dominantly caused by authigenic gypsum precipitation at depth, which is further confirmed by the dissolved Ca concentration.