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Paleostress value estimation using stylolite in evaporite of IODP core sample from Expedition 402 at the Tyrrhenian Sea

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Stylolite, a discontinuity between blocks of rock with complex mutual columnar interdigitation, is a pressure solution dehydration structure and is useful for estimating the paleostress. Stylolites are found in lithofacies such as limestones and evaporites, although only those in limestones have been used to estimate the paleostress. Stylolite formation could be a major contributor to the creation of sedimentary space after evaporite deposition in general. Therefore, the state of stylolite formation in evaporite is necessary to understand basin evolution. This study analyzes stylolites in evaporites collected by IODP Expedition 402 at Hole U1617B, located in the Tyrrhenian sea about 110 km southwest of the Italian peninsula, with the aim of estimating paleostress value at the time of stylolite formation.

Stylolites were photographed on the vertical section of cores perpendicular to the stylolites. Their traces were analyzed using the discrete Fourier transform method to estimate crossover-length L which separates two scaling regimes with different roughness exponents for small and large scales. Most stylolites show L as ~2 mm. Corresponding overburden stress $\sigma_{zz} \approx 9$ MPa assuming gypsum physical properties of Young's modulus E = 50 GPa, solid-fluid interfacial energy γ = 47 mJ/m^2, and Poisson's ratio ν = 0.25. The corresponding depth $z \approx 330$ m by assuming $\sigma_{zz} = \rho g z$, with rock density ρ = 2.7 g/cm^3 and gravitational acceleration g = 10 m/s^2. The water depth of the hole was 2822.33 m and analyzed stylolites were located at ~328 m below the sea floor. An estimated overburden stress value is not unnatural compared with the sampling depth, suggesting that stylolites in evaporite would also be useful for stress estimation. The gypsum-anhydrite transition is thought to occur at a burial depth of 500~1000 m. Therefore, stylolite formation in Hole U1617B would have occurred before the transition.

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