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Microstructural observations on hydrothermal veins of Site U1414, IODP Expedition 344 (CRISP 2)

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The erosive active margin offshore Osa Peninsula (Costa Rica) is characterized by the subducting Cocos Plate with its topographic height, the aseismic Cocos Ridge, which has lifted the seismogenic zone in the reach of scientific drilling. To understand the processes occurring in the subducting Cocos Plate in the vicinity to the Middle America Trench, we investigated microstructures in hydrothermal veins, transecting the lithified sediments and the igneous basement of IODP Hole U-1414A. Mechanical e-twinning occurred mainly in the blocky calcite veins in the lithified sediments, rather than in the fibrous calcite veins within the Cocos Ridge basalt. The differential stress, obtained from two different piezometers, indicate mean differential stresses of approximately 53 and 82 MPa. The majority of the twins show a significant thickness (up to 120 μm), straight twin boundaries and are indicative for deformation temperatures between 150 to 300°C.

The presence of additional deformation structures, such as undulose extinction and subgrain boundaries, indicates intracrystalline-plastic deformation by dislocation creep. The comparison of the EBSD data from two samples within the lithified sedimentary unit indicates diverse deformation temperatures. Variation in subgrain size observed for the different samples can be related to local variations in differential stress. The results of different microstructural observations showed, that the deformational history of Site 344-U1414 is characterized by distinct tectonic phases, occurring during the movement of the Cocos Ridge from its location of origin (the Galapagos hotspot) to the convergent margin offshore Costa Rica. The causes for these changes in deformation mechanisms in the studied rocks are ascribed to magmatic advection resulting in an increase of temperature and decrease of critical resolved shear stresses, as well as the bending of the Cocos plate adjacent to the Middle American trench.