コスタリカ沖前弧ウェッジの固結を支配する隆起過程と沸石沈殿
Sediment consolidation affected by uplift, mass movement, and fluid-interaction in the Costa Rica forearc wedge

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At the Middle America Trench offshore Costa Rica, Osa Peninsula, the aseismic Cocos Ridge subduct beneath the Caribbean Plate creating active seismicity. To investigate the geologic processes occurring at the Costa Rica margin, we examined the consolidation process and physical property transitions of sediments across the major unconformity developed in the wedge slope using the sediment cores of the middle slope Site 1380 recovered during Integrated Ocean Drilling Program (IODP) Expedition 344.The major unknowns of this margin which this study aim to investigate are the geologic events that created the major unconformity imaged from seismic surveys, and the lithology and consolidation state of the upper plate material beneath the unconformity. On the basis of sediment microstructural observation, physical property measurement, and geochemical composition analyses, we investigated the effects of burial diagenesis and fluid-sediment interaction towards the porosity-depth transition to extract the initial burial compaction curve and to access the maximum burial conditions beneath the unconformity.

The upper plate material below the unconformity developed in the wedge slope was revealed to be lithified sediments that are characterized by consolidation due primarily to burial compaction and mineral precipitation. Na-type zeolite: analcime exist only below the unconformity indicating precipitation during burial diagenesis whereas Ca-type zeolite: heulandite and laumontite are precipitated more broadly due to interaction with high temperature fluid (~100°C) that has likely localized in the vicinity of the unconformity. The experienced maximum temperature of the sediments below the unconformity based on the formation of analcime during burial diagenesis is estimated to range between 86°±5°C ~ 122°±2°C, which is above the current geothermal gradient. The change in zeolite assemblage indicate that the events of uplift from deeper depth and sediment removal have occurred across the unconformity. Beach deposits consisting of shell fragments and damage zones of normal fault regime were identified from the drilled cores above the unconformity, indicating that the sediments have uplifted to near sea surface involving faulting. By quantifying the weight percent of zeolites (laumontite, heulandite) formed by fluid interaction, the porosity decrease due to zeolite precipitation were estimated to be ~4-5% and the porosity-depth curve eliminating the effect of the fluid-interaction were recalculated. The depth along the approximate curve that corresponds to the porosity of the sediments directly below the unconformity corresponds to the maximum burial depth range: 1000±400 mbsf. After initial burial, the sediments have uplifted by minimum ~500 m to maximum 1500±400 m to near sea level, followed by subsidence of ~1050 m, associated with surface erosion of maximum 1000±400 m and/or normal fault displacement of maximum 450±400 m to reach the current depth range. If assuming a dip angle of the slope and fault plane to

be ~10-30°, this thickness of maximum mass movement would correspond to the distance of 4600±3400 m (surface erosion) and 2500±2400 m (normal faulting) parallel to the slope and fault respectively. These events occurred during 2.20±0.25 Ma ~ 1.71±0.24 Ma inferred from nannofossil age, which is likely to be consistent with the onset of Cocos Ridge/seamount subduction.
Uplift events are inferred to have occurred during seamount subduction, initiating mass movement, normal faulting, and subsidence in the Costa Rica margin. These processes resulted in significant exhumation of deeper sediments through surface erosion and/or extension and promoted active fluid interaction in high temperature which precipitated zeolites, contributing to the high consolidation in the forearc wedge. Sediment consolidation in the forearc wedge may consequently lift the updip limit of seismogenic zone to a shallower depth range.

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