Tilting of Eemian sea notches on the Thai-Malay Peninsula

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Erosion of limestone in tropical marine environments can lead to the rapid formation of distinct sea notches marking the position of the average sea level. Fossil sea notches at far-field sites outside the areas directly influenced by glacio-isostatic adjustment processes can therefore be used to infer the position of past global sea-level high-stands.

The Thai-Malay Peninsula is often considered to be tectonically stable on time scales relevant for reconstructing late Quaternary sea level variations. However, here we demonstrate that in Phang-Nga Bay on the western side of the Thai-Malay peninsula, sea notches that formed during the last interglacial about 130-115 ka (Eemian) show a distinct east-west tilt. Clear sea notches, both modern and fossils, can be observed in the Permian Ratburi Limestone that crops out along SSW-NNE trending chains of karst towers in Phang-Nga Bay. Sea notches on the eastern side of the bay are about two meters higher relative to sea notches on the western side of the bay, with sea notches in the middle of the bay having intermediate values.

The elevation of the sea notches was measured using laser range finders and all measurements were tied to the local datum using GNSS with an error typically smaller than 10 cm. Only distinct sea notches that could be traced out horizontally were used. Because older sea notches are typically overgrown by tufa formations and flowstones, only clear measurements from notch ceiling and notch floor were used. A compilation of the measurements shows that sea notches across the bay show similar heights from floor to ceiling, but that there is a clear trend with higher elevations in the East relative to the West. No such trend could be seen in the north-south direction. Because sea notches are erosional features, absolute dating is often difficult. However, oysters found in situ in crevasses in the ceiling of the sea notches have infinite radiocarbon ages, demonstrating that these notches must have formed long before the Holocene sea-level high-stand, but the amount of overgrowth and the general erosion rate make it unlikely that the observed notches should be remains of the MIS 11 sea-level high-stand. Consequently, we conclude that the most likely age of the wide-spread upper sea notches matches the Eemian (MIS 5e) sea level high-stand.

Because the east-west difference in elevation of the Eemian sea notches is roughly perpendicular to the direction of the Khlong Marui strike-slip fault, we postulate that movement along the Khlong Marui fault over the past ca. 100 ky have resulted in about two meters of vertical movement of the landscape. Consequently, on longer time scales, the vertical movements of the Thai-Malay Peninsula must be considered when reconstructing past sea level variations.