Paleotemperature anomalies deduced from thermal-maturity parameters within the décollement, off Cape of Muroto, Japan

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Heat flow is characteristically high at the toe of the Nankai accretionary prism, off cape Muroto, and this is considered to be a consequence of the subduction of a hot and active ridge (e.g. Yamano et al., 2003). Despite present-day heat flow being known, how heat has changed over time in this area remains uncertain and is poorly constrained. To address this question, we have investigated palaeotemperatures using thermal maturity parameters measured on cores collected during IODP Expedition 370. Paleotemperature data were evaluated within the context of present-day heat flow and expected changes in temperature with respect to depth; e.g., numerical constraint whether present-day temperatures are too hot or cold to explain thermal maturity measurements, and whether there are anomalies with respect to depth. This is particularly important for Expedition 370 (T-limits) which selected the Muroto-site (Site C0023) because of its high heat flow and the chance this offers to investigate the habitability of the deep biosphere with respect to the temperature. Site C0023 is located 120 km from Cape Muroto, and is in the protothrust-zone of the Nankai accretionary prism. The hole encountered the décollement at 758-795 mbsf, and present-day temperatures were measured down to ~350 mbsf. Vitrinite reflectance was used to estimate maximum paleotemperatures and to look for thermal anomalies. The vitrinite reflectance increases with depth from 0.2 to 0.6 % from 200 to 700 mbsf, typical of conventional burial metamorphism, but changes little from 700 to 1000 mbsf (values stay about 0.6 %). There is a notable high value at 1090 mbsf (about 1%). There are anomalously high values of both vitrinite reflectance and sterane and hopane biomarker data at about 800 mbsf. For heating durations of 400, 4000, 40000 and 400000 years, and assuming thermal maturation using the EasyVit model of Burnham and Sweeny (1990), temperatures of 40~140 ℃ can explain data between 200 to 750 mbsf. To match measurements of vitrinite reflectance at 750 mbsf, a maximum paleotemperature of 140 ℃ is required. At 1090 mbsf, temperatures as high as ~200 ℃ could be needed. The difference between the paleo- and present-day temperatures is the notably the greatest at the décollement, strongly suggesting an elevated heat flow at some time. A heating duration of 400 years, an elevated a heat flow of 130 ±90 mW/m^2 and a temperature > 150 ℃ can explain the observations on the vitrinite reflectance. Considering the scales of space and time of thermal advection, a high-temperature fluid along the décollement zone is our currently preferred explanation.

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