Estimation of paleo-geothemal gradient and its interpretation from the on land accretionary complexes

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Introduction

Estimations of paleo-geothermal gradient have been conducted from the on land accretionary complexes by many workers. On the basis of the estimated paleo-geothermal gradient, they have argued about age of subducted plate slab and material migration path. In the re-investigation of on land accretionary complexes as fossil seismogenic zone along subduction plate interface, geothermal gradient is one of the significant information to understand the P-T condition of seismogenic zone. There is, although, so far no consensus on the geothermal gradient from the on land accreitionary complex. This may be due to differences in the understandings of methods to estimate of geothermal gradient and timing of the geothermal event. In this paper, we examine the methods to estimate geothermal gradient from the ancient accretionary complexes and discuss the interpretation of the estimated geothermal gradient. In following, we use the value of thermal conductivity as 2.5W/m/C.

Methods to estimate geothermal gradient

Estimation from age of subducting slab

Parsons and Sclater (1977) suggested that estimation of heat flow from subducting slab is estimated from age of subduction plate. This is assumption under conductive heat effecting hole geothermal structure.

Younging trend of plate age from the north to the south is reported from the Cretaceous m_lange zones by Taira et al. (1988). The zones contains 60m.y., 39m.y., 15m.y., and younger than 10m.y of slab age. On the basis of the Pasrons and Sclarter (1977)'s method, geothermal gradients are estimated as 24.5C/Km, 30.4C/Km, 49C/Km and 60C/Km, respectively.

Illite crystalinity and illite b0 lattice spacing

Awan and Kimura (1996) estimated geothermal gradient using illite crystalinity and illite b0 lattice spacing from the Cretaceous Shimanto belt, Kii Peninsula. They resulted about 22C/Km and 31C/Km.

Vitrinite reflectance

Vitrinite reflectance is considered to record paleo-maximum temperature.

Ikehara-Ohmori (2001) proposed geothermal gradient about 30C/Km from vitrinite reflectance and altitude of sample location.

Fluid inclusion

Lewis et al (2000) and Hashimoto et al. (submitted) reported the P-T condition from fluid inclusion trapped within mineral veins. Lewis et al (2000) focused on the final stage vein of accretion history. Hashimoto et al. (submitted) analyzed syn-melange vein developing only in melange blocks. Sakaguchi (1996) combined vitrinite reflectance and fluid inclusion to estimate maximum P-T condition. In the result, Lewis et al (2000), Sakaguchi (1996) and Hashimoto et al (Submitted) proposed geothermal gradients 58-77C/Km, 90C/Km and 10C/Km respectively.

Discussion and conclusion

Sakaguchi (1992) and Ohmori (1996) revealed a linear trend of vitrinite reflectance increasing from the north to the south. The trend is repeated between out of sequence thrusts. This regional trend indicates that the thermal structure is constructed by conductive heat. There are, however, some exceptions indicating localized high temperature. For this problem, Sakata (2002) investigated Kentin melange where hydrothermal activity is high. He concluded hot fluid does not affect regional geothermal structure but localized thermal structure. Therefore, geothermal gradient estimated from regional linear trend may be most accurate data. Geothermal gradient estimated from mineral veins along fault is possible not to indicate hole geothermal gradient but to show localized P-T condition.

Geothermal gradient estimated from syn-melange vein may also indicate localized P-T condition. Under the interpretation that tectonic melange is formed due to shear along decollement, the geothermal gradient estimated from syn-melange vein indicates the geotherm along decollement. The result of 10C/Km of geothermal gradient suggests that the geothermal gradient along decollent is too low.