Strength of the geomagnetic field during the Holocene deduced from the surface lavas on the island of Hawaii

*Yuhji Yamamoto[1], Ryo Yamaoka[1]

1. Center for Advanced Marine Core Research, Kochi University

The Earth's magnetic field originates from the geodynamo, namely fluid motion of a conductive liquid outer core. Information on the strength of the geomagnetic field, namely paleointensity, is important to understand the behavior of the geodynamo. Among geologic materials volcanic rocks have been typically used to deduce an absolute paleointensity (API): volcanic rocks give absolute paleointensity sporadically in time, and vast amount of the API data have been reported mainly since 1960s and compiled into the PINT database (http://earth.liv.ac.uk/pint/; Biggin et al., 2009). The latest update of the database was done on May 2015: it involves 9,466 APIs for the past 0.05-3458 million years.

API estimates during the Holocene period (last 10 kyr) is important for linking paleomagnetic and present-day geomagnetic observations. As pointed out by Cromwell et al. (2017), the island of Hawaii is one of the most studied subaerial locations in the world to recover Holocene APIs. Many published data from the island are accessible also in other paleointensity databases, such as GEOMAGIA (Korhonen et al., 2008; Brown et al., 2015) and MagIC (Tauxe et al., 2016). For example, if we apply site-level selection criteria with (1) a minimum of three successful results for a site (N>=3) and (2) successful results providing a site mean with a standard deviation less than 15 % of the mean (stdev =< 15 %), 55 site-mean APIs obtained by the Thellier-type method with pTRM checks can be selected from the GEOMAGIA50.v3 database (Brown et al., 2015).

Since around 2000s, there seems a becoming consensus that volcanic rocks are not so ideal materials due to such as magnetic grains other than non-interacting single domain particles. Many researchers have been made effort to propose tests for detecting non-ideal behaviors and strict selection criteria to reject suspicious API estimates. It is appropriate to reassess the published data. From newly collected glassy volcanic materials from Holocene surface lavas on the island of Hawaii, Cromwell et al. (2017) obtained 22 new site-mean APIs by the IZZI Thellier method (Tauxe and Staudigel, 2004), which is a blocking-temperature-based paleointensity method, with the stringent selection criteria "CCRIT" (Tauxe et al., 2016). They compared these data to the previously published data based on cumulative distribution function (CDF) diagrams together with five site-mean APIs of the same quality that were obtained from historical surface lavas on the island of Hawaii by Cromwell et al. (2015). They found that the CDF curve of their dataset (IZZI dataset; median of 43.5 microT, N = 27) was shifted to lower paleointensity values than those of the previously published Thellier-type data (median of 54.5 microT, N = 74).

To obtain a new paleointensity dataset based on coercivity spectra rather than blocking temperature spectra, we applied the Tsunakawa–Shaw method (Yamamoto et al., 2003) to Holocene surface lavas collected from 34 sites on the island of Hawaii. In total, 135 successful results were obtained after applying specimen-level selection criteria, yielding 22 site-mean Tsunakawa–Shaw APIs (TS dataset) that fulfilled the site-level selection criteria. We compared the TS dataset with the IZZI dataset. The CDF curve of the TS dataset, except for three sites, almost overlaps that of the IZZI dataset, and a median of the TS dataset (42.9 microT, N = 19) coincides with that of the IZZI dataset. The coincidence of the CDF curves suggests equivalent reliability of the Tsunakawa–Shaw method and the IZZI Thellier method. The

Holocene paleointensity variation in Hawaii is thought to be reliably characterized by both the TS dataset and the IZZI dataset: overall, the paleointensity throughout the Holocene is suggested to be higher than the present-day field.