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High-resolution records of non-dipole variations derived from volcanic edifices

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Our understanding of the short-term behavior of the Earth's magnetic field is currently mainly hampered by a lack of coeval high-resolution records of geomagnetic intensity variations that are well distributed over the globe. Lavas are the only recorder of short-term fluctuations of the geomagnetic field that are available for all parts of the world and on geological time scales. Therefore, many efforts have been made to improve the methodology to obtain reliable estimates of the paleointensity from igneous rocks over the past decades. It is well known that some paleointensity methods will work on certain lavas with specific thermomagnetic behaviour, but fail for others.

We therefore propose a 'multi-method paleointensity approach' that consists of Thellier-style, multispecimen-style, and calibrated pseudo-Thellier-style experiments to construct high-resolution records of regional variations in the intensity of the Earth's magnetic field. With our new approach we obtain a reliable estimate of the paleointensity for 60-70 percent of all cooling units sampled.

By applying our new approach to suites of lavas from Hawaii (USA), and the Canary Islands (Spain) we obtain important constraints for short-term local geomagnetic intensity highs, and insight into their possible driving mechanisms. Our new record for Hawai'i indicates that, approximately 1000 years ago, the local field intensity increased on the order of 50% for 200 years – a qualitatively similar phenomenon observed 200 years earlier in western Europe (Gallet et al., 2005; Gomez-Paccard et al., 2012) and 500 years later in southwestern USA (Bowles et al., 2002). When these records are combined with a record for Japan (Yu, 2012), a coherent picture emerges that includes the dipole component decaying steadily since at least 1000 years ago. Superimposed onto this decay are strong but shorter-term intensity variations at a regional level whose asynchronicity necessitates a highly non-dipolar nature. Our paleointensity data obtained for Tenerife reveal high paleointensities temporally coinciding with an intensity high occurring in the Middle East around 1000 BC. If our findings are related to this 'archeomagnetic jerk', it must have extended more than 50 degrees westward in longitude.

References:
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