Foulger, G.R., G.F. Panza, I.M. Artemieva, I.D. Bastow, F. Cammarano, J.R. Evans, W.B. Hamilton, B.R. Julian, M. Lustrino, H. Thybo and T.B. Yanovskaya, Tomography & Geochemistry: Precision, Repeatability, Accuracy and Joint Interpretations, EOS Trans. AGU, Fall Meet. Suppl., Abstract ID# 74747, Abstract S23D-2765, 2015.

Tomography & Geochemistry: Precision, Repeatability, Accuracy and Joint Interpretations

Gillian R. Foulger[1], Giuliano F. Panza[2], Irina M. Artemieva[3], Ian D. Bastow[4], Fabio Cammarano[3], John R. Evans[5], Warren B. Hamilton[6], Bruce R. Julian[1], Michele Lustrino[7,8], Hans Thybo[3], Tatiana B. Yanovskaya[9]

[1]Dept. Earth Sciences, Durham University, Durham, U.K.

[2] Dept. Mathematics and Geosciences, University of Trieste, Italy and the Abdus Salam ICTP - SAND Group, Trieste, Italy & Inst. Geophysics, China Earthquake Administration, Beijing, China.

[3]Dept. Geography and Geology, University of Copenhagen, Denmark

[4] Dept. Earth Science and Engineering, Imperial College, London, SW7 2AZ, UK

[5]U.S. Geological Survey, Menlo Park, CA 94025, U.S.A.

[6]Dept. of Geophysics, Colorado School of Mines, Golden CO 80401, U.S.A.

[7] Dipartimento di Scienze della Terra, Università degli Studi di Roma La Sapienza, P.le A. Moro, 5, 00185, Rome, Italy

[8]CNR – Istituto di Geologia Ambientale e Geoingegneria (IGAG) c/o Dipartimento di Scienze della Terra, Università degli Studi di Roma La Sapienza, Rome, Italy

[9]Dept. Physics of the Earth, Sankt-Petersburg State University, Sankt-Petersburg, Russia

Seismic tomography can reveal the spatial seismic structure of the mantle, but has little ability to constrain composition, phase or temperature. In contrast, petrology and geochemistry can give insights into mantle composition, but have severely limited spatial control on magma sources. For these reasons, results from these three disciplines are often interpreted jointly. Nevertheless, the limitations of each method are often underestimated, and underlying assumptions de-emphasized. Examples of the limitations of seismic tomography include its ability to image in detail the three-dimensional structure of the mantle or to determine with certainty the strengths of anomalies. Despite this, published seismic anomaly strengths are often unjustifiably translated directly into physical parameters. Tomography yields seismological parameters such as wave speed and attenuation, not geological or thermal parameters. Much of the mantle is poorly sampled by seismic waves, and resolution- and error-assessment methods do not express the true uncertainties. These and other problems have become highlighted in recent years as a result of multiple tomography experiments performed by different research groups, in areas of particular interest

e.g., Yellowstone. The repeatability of the results is often poorer than the calculated resolutions. The ability of geochemistry and petrology to identify magma sources and locations is typically overestimated. These methods have little ability to determine source depths. Models that assign geochemical signatures to specific layers in the mantle, including the transition zone, the lower mantle, and the core-mantle boundary, are based on speculative models that cannot be verified and for which viable, less-astonishing alternatives are available. Our knowledge is poor of the size, distribution and location of protoliths, and of metasomatism of magma sources, the nature of the partial-melting and melt-extraction process, the mixing of disparate melts, and the re-assimilation of crust and mantle lithosphere by rising melt. Interpretations of seismic tomography, petrologic and geochemical observations, and all three together, are ambiguous, and this fact needs to be emphasized more in presenting interpretations so that the viability of the models can be assessed more reliably.