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Geologic phenomena such as basaltic volcanism and uplift in intraplate regions such as Hawaii and Deccan have been considered to be caused by mantle plumes from the deep mantle. However, some skeptics argue that such geologic phenomena are caused by shallow mantle processes such as plate tectonics. Recently, the debate between plume advocates and skeptics has become heated, and attracted the attention of Earth scientists from all over the world. From the view point of magma genesis in Japan, this debate is notable since basaltic volcanism along the back-arc side of the southwest Japan arc has been suggested to be caused by mantle plumes.

Under these circumstances, the AGU Chapman conference ‘The Great Plume Debate’ was convened at the Ben Nevis Hotel, Fort William, Scotland from 26 August to 5 September 2005. 85 plume advocates and skeptics from 25 countries gathered to discuss the mantle plume hypothesis and alternatives. The conference was convened by I. H. Campbell (ANU), G. R. Foulger (Durham Univ.) J. H. Natland (Miami Univ.), D. C. Presnall (Carnegie Inst. Washington) and W. J. Morgan (Harvard Univ.). I attended the conference as a postdoctoral researcher of JNC (JAEA at present). I report an outline of the conference. From Japan, E. Takahashi (TIT) and D. Zhao (Ehime Univ.) also attended.

The conference comprised 5 days of presentations, two halfday field trips, a pre-conference field trip to the Isle of Rum and post-conference field trips to the islands of Skye and Mull (3 days and 2 nights each). The presentations comprised 15 sessions each 90 minutes long. Three keynote speeches (15 min each) and associated debates (15 min each) constituted each session. In each session, plume advocates presented first, and then plume skeptics presented. Presentations using posters also accompanied each session. The posters were displayed all day. Discussions of them were carried out during intermissions between the oral sessions and after dinner.

August 28

The session of “*Plume theory & predictions*” took place in the first half of the morning, I. H. Campbell and W. J. Morgan presented outlines of the plume theory. The session entitled “*Alternative theories & predictions*” took place in the second half. G. R. Foulger discussed a plate tectonic model, L. T. Elkins-Tanton (Brown Univ.) discussed a lithospheric delamination model and D. T. Sandwell (Scripps Inst. Oceanography) proposed a crack model to explain the origin of intraplate volcanism.

In the afternoon, the sessions “*Lithosphere & mantle physics I & II*” took place. J. H. Davies (Cardiff Univ.), U. Hansen (Muenster Univ.), J. A. Tarduno (Univ. Rochester), E. Burov (Univ. Paris), S. D. King (Purdue Univ.) J. van Wijk (Scripps) and W. D. Stuart (USGS, Menlo Park) presented their models. I was most interested in the presentation of E. Burov. He discussed the interaction between a plume head and lithosphere based on a realistic rheological model for continental lithosphere. His model demonstrated that the vertical motions caused by plume

head/lithosphere interaction would be more complex than previously realised. After dinner, I. W. Dalziel (Texas Univ.) lectured on the geology of the Scottish Highlands in the context of super-continent behaviour.

August 29

In the morning sessions entitled “*Temperature I & II*”, N. T. Arndt (Univ. Grenoble), M. J. Cheadle (Univ. Wyoming), C. M. Leshner (Laurentian Univ.) R. N. Harris (Univ. Utah), D.C. Presnall and T. J. Falloon (UTas) presented. In my opinion, the most precise and appropriate temperature estimations are those presented by T. J. Falloon for Hawaii and MORB using basalt chemistry. In this session, I gave a poster presentation on the thermal state of the NW Kyushu mantle as suggested by basalt chemistry. In the afternoon, the participants enjoyed a half day field trip to Ballachulish and Glen Coe, where we studied an ancient caldera collapse.

August 30

In the morning sessions entitled “*Geochronology I and II*”, R. A. Duncan (Oregon State Univ), K. A. Hoernle (GEOMAR), A. A. Koppers (Scripps), A. K. Baksi (Louisiana State Univ) and J. M. O’Connor (Vrije Univ.) gave presentations. The main issue in this field is how we evaluate the effects of alteration in K-Ar and Ar-Ar dating of oceanic island basalts. In the afternoon session entitled “*Seismology I and II*”, R. M. Allen (UCBK), D. Zhao (Ehime, Univ.), G. Nolet (Princeton Univ.), A. Deuss (Univ. Cambridge), B. R. Julian (USGS, Menlo Park) and T. Lay (UCSC) gave oral presentations. Zhao argued that high velocity anomalies in mantle tomography images are subducted slabs and low velocity anomalies are mantle plumes. I felt that the problems in this field are how we evaluate the resolution of tomography, and the effects of heterogeneity of the mantle. In the after-dinner session entitled “*Planetary*”, A. P. Jones (Univ. College London), C. C. Reese (Washington Univ), V. Hansen (Univ. Minnesota) and W. B. Hamilton (Colorado School of Mines) presented. In this session meteorite impacts were proposed as an alternative to mantle plumes.

August 31

In the morning, the sessions “*Field evidence I and II*” took place. A. Saunders (Univ. Leicester), S. M. Jones (Trinity Collage), Y. G. Xu (Guangzhou, Inst. Geochemistry), H. C. Sheth (IIT) and V. Sallarès (UTM) and E. L. Winterer (Scripps) presented. Details of the Emeishan flood basalts, presented by Xu, attracted the attention of the audience as a typical case where the geologic phenomena expected by the classical plume model are observed. I felt that evaluation of the effect of preexisting geologic structures on tectonic activity related to intraplate volcanism at each locality is important. In the afternoon, a half-day trip entitled “*The road to the Isles*” took place. In this field trip, we studied metamorphic rocks migmatized to change into granites.

September 1

In the morning, the sessions entitled “*Petrology and Geochemistry I & II*” took place. C. Hawkesworth (Univ. Bristol), J. M. Rhodes (Univ. Massachusetts), E. Takahashi, G. Fitton (Univ. Edinburgh), M. Keskin (Istanbul Univ) and A Scherstén (Vrije Univ.) gave presentations.

Based on melting experiments, Takahashi argued that Hawaiian picrites were formed by the reaction between partial melts of recycled oceanic crust and peridotites. In the afternoon, sessions entitled “*Discussion I, II and Synthesis*” took place. Discussions in these sessions revealed that plume skeptics are discontent with the ambiguity of evidence for the plume hypothesis. On the other hand, plume advocates felt that alternative models could not explain the high melt production rates of flood basalts and Hawaii. It seems to me that the ultimate issue of this debate is how we explain continental breaks in the context of models other than the plume hypothesis.

September 2

In the afterglow of successful discussions, the participants left Fort William. Takahashi and I attended the post-conference field trip to the Isle of Mull. I report on this trip elsewhere.

Abstracts, PowerPoint slide shows of some oral presentations, and PDFs of some poster presentations, can be accessed at <http://www.mantleplumes.org/Chapman/Information.html>. Papers based on some presentations will be published as Geological Society of America Special Paper.

Almost all fields of Earth Science are relevant to the mantle plume debate. Many debates in each field have not been settled yet. Researchers out of the field, however, are not aware of this and refer interpretations out of their fields of speciality as well-proven facts. This makes the plume debate more complex. At this conference, all the presentations took place in the same room, and equal time was allocated to presentations and discussions. People on both sides of the debate discussed with adversaries at the conference and researchers from other fields witnessed. This enabled researchers to understand the issues in specialties other than their own, and to recognize that problems remain in each field.

Alternative models to mantle plumes are unfamiliar to Japanese Earth Scientists. Most of us are not interested in this debate. At the EGU 2006 and IAVCEI 2006 Assemblies, however, there will be special sessions related to the plume debate. Last autumn, a special publication entitled “*Plates, Plumes, and Paradigms*” was published by the Geological Society of America. Its daughter special publication, entitled “*Plates, Plumes, and Planetary Processes: The Origins of Melting Anomalies*” is currently in preparation. Interest in the plume debate is increasing more and more outside of Japan. However, even in Japan, geologic phenomena are explained by mantle plumes, such as oceanic island type basalts and the formation and extinction of sedimentary basins in southwest Japan. Through studies of such geologic phenomena, Japan will contribute to the debate. In the fields of sedimentology and structural geology related to basin formation and extinction, Japanese geologists excelling in detailed geologic observations can play important roles in the debate. In the conference, I felt that the evaluations of geologic phenomena related to subduction are inadequately represented in the debate, probably because most of the participants live along the Atlantic margins. Japanese geologists living on a subduction zone have a geologic background different from that of Atlantic geologists. The insights of Japanese geologists could thus provide new viewpoints to this debate and contribute to its progress.

The website <http://www.mantleplumes.org/> managed by G. R. Foulger contains a huge amount of information related to the mantle plume debate. I recommend visiting this website. G. R. Foulger is a plume skeptic, but the website is open to contributions from all researchers working on mantle plumes. Contributions both from plume advocates and skeptics are welcomed. Contributions from Japanese researchers are warmly welcomed. Visit the website for detailed information about making contributions.

When I was a student at Kyushu University, teachers often told me about the plate tectonic revolution in Japan, when geologists abandoned the geosyncline hypothesis and adopted the accretion hypothesis instead (Sedimentologists from Kyushu University played important roles in the revolution in Japan). For young researchers who have not experienced a scientific debate comparable to a paradigm shift, the mantle plume debate is a good educational subject that shows that Earth Science is a developing field which is not completely finished yet. The mantle plume debate demonstrates for us the essential facets of a scientific debate. In order to understand the debate well, I recommend reading "*Patterns of Discovery*" (N. R. Hanson), "*The Copernican Revolution.*", "*The Structure of Scientific Revolutions*" (T. S. Kuhn) and "*What is scientific revolution*" (A. Miyashiro, in Japanese only).