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Preface: Geoscience dynamics in the Patagonia Archipelago —Southern Pacific Ocean

YUJI ORIHASHI,[1]* RYO ANMA,[2] NAOMI HARADA[3] and NATSUE ABE[4]

[1]Earthquake Research Institute, The University of Tokyo, Bunkyo-ku, Tokyo 113-0032, Japan
[2]Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba 305-8572, Japan
[3]Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka 237-0061, Japan
[4]Institute for Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Yokosuka 237-0061, Japan

Patagonia, antipodal from Japan, attracted explorers' imagination as a trackless region in the early 20th century. Famous explorers such as Eric Shipton aimed in the 1950s to put the first footprint on the Andean peaks in the Patagonia Icefield, the largest temperate ice body in the Southern Hemisphere (Shipton, 1959, 1960). The first Japanese expedition, conducted by Kobe University in 1957, scaled Mt. Arenales in the Patagonia Icefield (Takagi, 1968). The Academic Alpine Club of Hokkaido (AACH) sent the first scientific exploration parties to Patagonia in 1965 and 1967 (Hokkaido University Patagonia Committee, 1974). Fifty years have passed since those pioneer works. Numerous studies were done in Patagonia by scientists from all over the world including geologists, volcanologists, glaciologists, sedimentologists, and oceanographers. This special issue, by reviewing decades of such scientific effort, aims to portray where we are and to present a view of where we are headed by collecting the results obtained at the cutting edge of science.

The main body of this volume consists of results from three independent projects led by Japanese researchers: the Glaciological Research Project in Patagonia (GRPP) for glaciology, the CHile RIdge Subduction To MAgma Supply SYstem (CHRISTMASSY) project for geology, volcanology, and tectonics, both supported by JSPS KAKENHI Grants, and two R/V *Mirai* cruises operated by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in the Southern Pacific, and Chilean coastal and fjord areas: MR03-K04 Leg3 (BEAGLE2003 Cruise data and report; Harada, 2004) and MR08-06 (SORA2009 Cruise data and reports; Abe, 2009; Harada, 2009) for biogeochemical and physical oceanographies, paleoceanography, geophysics, and sedimentology. The purpose of the R/V *Mirai* cruises include understanding of abrupt changes in the biological pump, which transports carbon from the surface to the deep ocean, sea-surface temperatures, and understanding of the ventilation rate of the intermediate water, which are related to glacial and inter-glacial climate changes. The MR08-06 cruise was intended also to elucidate the influence of subduction of young and hot oceanic crust and subducted sediments on the composition of magma that had intruded into the overriding continental crust.

While the current global warming has been occurring, understanding the enhancement or reduction of glaciers in association with climate change during the geological past would be thought-provoking. Aniya (2013) reviewed Holocene glaciations at Hielo Patagónico (Patagonia Icefield) and proposed the new scheme of five Neoglaciations: I at 4.5–4 kilo year before present (kyr BP), II at 3.6–3.3 kyr BP, III at 2.7–2 kyr BP, IV at 1.6–0.9 kyr BP, and V at the 17th–19th centuries, the Little Ice Age (LIA). A study of the isolated temperate glaciers provides direct and important implications for paleo-climate changes in the Southern Hemisphere.

The sequential record for paleo-climate changes are usually best recorded in marine and/or lake sediment cores. Sediment cores obtained using the R/V *Mirai* cruises have provided invaluable information. Shiroya *et al*. (2013) extended the history of the reduction of the Patagonian glacier toward the deglaciation and the Holocene, using terrigenous input based on Al_2O_3 recorded in the marine sediments at Magellan Fjord, 53°S and Drake Passage, 55°S. Results show that the predominant Holocene melting event occurred at *ca*. 8 and *ca*. 10 calendar kyr BP (cal kyr BP), respectively, at Magellan Fjord and Drake Passage. The less nutrient and fresh water mass created by the glacier melting event negatively influenced the biological productivity in the Strait of Magellan (Fukuda *et al*., 2013). The biological material fluxes were low during 13–6 cal kyr BP. Thereafter, they abruptly increased, suggesting that the productivity at the Strait of Magellan might be controlled mainly by Southern westerly winds migration except for the glacier melting. Fukuda *et al*. (2013) also reported that the biological

*Corresponding author (e-mail: oripachi@eri.u-tokyo.ac.jp)

material fluxes were high during 13–6 cal kyr BP at the lower latitude (36°S) at which productivity was controlled by changes in upwelling intensity.

The remainder of the volume is dedicated to geodynamics and magmatism in the Southern Pacific Ocean and Patagonia. The most prominent geodynamic feature in the Southeastern Pacific margin is the presence of a ridge–trench–trench type triple junction off Taitao Peninsula, the westernmost promontory of Chilean coast, where Nazca and Antarctica plates separated by the Chile Ridge system subduct together underneath the South American plate.

Matsumoto *et al*. (2013) compiled the seafloor geophysical measurement data newly obtained from the Chile Triple Junction (CTJ) area during the MR08-06 cruise, and compared them with NGDC/NOAA data. They estimated that the spreading rate decreases and that the volcanic activity diminishes gradually to the subducting ridge axis as a segment of the Chile Ridge enters to the ridge subduction zone. The single channel seismic data constrained distribution of sediments covering the ridge subduction system.

Anma and Orihashi (2013) focused on magmatism in the Chile margin related to the ridge subduction off the Taitao Peninsula at *ca*. 6 Ma. They used the age distribution of clastic zircons in sedimentary rocks dredged from the CTJ area during the MR08-06 cruise as a proxy for sediment incorporation into magmas, and argued for eduction of melts at shallow levels, formed because of partial melting of subducted oceanic crust and sediments. They also demonstrated that the volcanism in the Chile margin migrated at a rate of 5 cm/y from west to east during subduction of a fracture zone. Kon *et al*. (2013) used trace element geochemistry to elucidate the petrogenesis of plutonic rocks intruded at 5.2 Ma and 4.0 Ma into marginal zones of the 5.7 to 5.2 Ma Taitao ophiolite, products attributable to ridge collision at *ca*. 6 Ma. They reported that the plutons have a calc–alkaline arc signature and that they might have been formed at garnet-free amphibolite conditions through partial melting of the subducted oceanic crust.

Shinjoe *et al*. (2013) demonstrated the usefulness of the fluid mobile/immobile element ratio, and especially of boron, to examine slab-derived components accreted into the wedge mantle using the volcanic rocks of Southern Volcanic Zone in the Andes. They suggested that an along-arc compositional variation is controlled by the ratio of altered oceanic crust-derived and/or sediment-derived fluids and sediment melt that contaminated the mantle sources at the root zones of the volcanoes.

Two important contributions, one extending the scope of this special issue to the Mesozoic analogue of the current Patagonian geodynamics (Calderón *et al*., 2013), and the other extending it to the lithospheric mantle compositions (Bertotto *et al*., 2013), are included in this issue. Calderón *et al*. (2013) provided petrological, geochemical, and geochronological constraints for the ophiolites in the Rocas Verdes Basin developed behind the Late Jurassic Chilean margin to discuss tectonic, magmatic, and metamorphic history of a supra-subduction rift zone that underwent a transition to a back-arc basin, and which closed eventually during the Andean orogeny. Bertotto *et al*. (2013) showed petrochemical characteristics of mantle xenoliths found in Pleistocene basaltic lavas and pyroclastic deposits from Agua Poca volcano, Argentina. Based on the result of microanalysis for the clinopyroxene, the mantle xenoliths were of fertile peridotites, formed by melt extraction up to 13% having a primitive mantle composition since the Proterozoic age, which was only affected subordinately by the metasomatic overprint of hydrous basaltic melt accompanied with Neogene back-arc volcanism.

Orihashi *et al*. (2013) discovered numerous zircon xenocrysts in a Middle Miocene adakitic body in Cerro Pampa, Argentina, and used them to infer the evolutionary history of the underlying crust. Their results provide concrete evidence that supports a young growth history of the Patagonian continental crust, started at the Gondowana margins in the Paleozoic and continued to the beginning of Late Cretaceous. An important implication of this study might be that they provided a new tool to distinguish adakites that had undergone crustal contaminations from those derived directly from slab-melting.

Two papers reporting recent findings related to magmatism in the Southern Pacific basins are included at the end of this volume. Hirano *et al*. (2013) described geochemical features of basaltic rocks that had been newly dredged during the MR08-06 cruise from small knolls in the Nazca Plate off the Chile Trench. They concluded that the eruption occurred as a response to plate flexure at the outer rise. This discovery of so-called petit-spot magmatism is the second after the discovery in the outer rise in the Northwestern Pacific off northeastern Japan (Hirano *et al*., 2006), and might imply that such magmatism is common in plate flexure zones worldwide. Suetsugu and Hanyu (2013) reviewed seismological and geochemical studies of the whole mantle structure beneath the Southwestern Pacific superswell. They proposed a model incorporating a thermochemical superplume extended from the core–mantle boundary to a depth of 1,000 km and secondary narrow plumes generated from its superplume southward Pacific hotspots. The revealed structure also supports generation of an HIMU reservoir, and that the oceanic crust should sink into the lowermost mantle and melt, which would metasomatize the ambient mantle.

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