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Interhemispheric observations of field line resonance frequencies as a continuous function of ground latitude in the auroral zones

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In the austral summer of 2006–2007, the 48th Japanese Antarctic Research Expedition (JARE-48) installed two unmanned low-power magnetometers to form a closely spaced magnetometer network in combination with the permanent sites at Japan's Syowa Station in Antarctica. To identify field line resonances (FLRs), gradient methods are applied to the data from three adjacent sites in Antarctica and data from conjugate points in Antarctica and Iceland. By analyzing the data from the Antarctic and Icelandic sites individually, the structure of FLRs with high coherence is clearly identified. However, by analyzing the data from closely spaced Antarctic sites, it is more difficult to identify the signature of FLRs because of the inclusion of multiple signals related to the local geomagnetic pulsations over a broad frequency range. The frequency and resonance width of FLRs are determined by applying the amplitude phase gradient method (APGM) to the data from Antarctic sites. This yields the eigenfrequency as a continuous function of ground latitudes in the area surrounding Syowa Station. The mass density in the equatorial region at the L of the auroral zones is estimated from the obtained FLR frequency by numerically solving the standing Alfv?n wave equation. The mass density thus obtained is consistent with observational results from previous in situ measurements by spacecraft. The results of the present study demonstrate that data from geomagnetic conjugate points are helpful in identifying FLR in cases in which the magnetometers are too close to each other to enable identification. Once FLR is identified, APGM can be applied to the identified FLR, yielding the FLR frequency as a continuous function of ground latitudes. Therefore, the magnetospheric equatorial mass density is readily estimated with high spatial resolution.

Origin of sapphirine-bearing garnet-orthopyroxene granulites: possible hydrothermally altered ocean floor

Sotaro Baba, Ryuichi Shinjo, Brian F. Windley

Sapphirine is a metamorphic mineral that forms in the deep crust in rocks with distinctive bulk compositions, in particular high concentrations of Mg and Al. This study investigates a thin, discontinuous layer of sapphirine-bearing garnet-orthopyroxene (SGO) granulite within a Palaeoproterozoic mafic granulite together with metamorphosed mafic and ultramafic rocks, micaceous rocks rich in magnetite and pyrite, and marble. All of these rocks occur within a low-strain zone in the Lewisian complex of South Harris, NW Scotland. Data on mineral compositions and major, trace, and rare earth element (REE) patterns provide evidence for the origin of the precursor of the SGO granulite. The host mafic granulite has a trace element signature and REE pattern comparable with that of E-type MORB. The chemical abundances of Nb, Ta, La, Ce, Nd, Zr, Hf, Ti, and V in the SGO granulite, except for one sample that records total element loss, are similar to those of the host mafic granulite; however, in terms of whole-rock element abundances, the former is relatively enriched in MgO and depleted in CaO, Na2O, MnO, Sr, and Eu. Elements within the SGO granulite that were apparently unaffected by hydrothermal alteration—V, Y, Zr, and Cr—are within the range of values observed in the host mafic granulite. Sm-Nd whole-rock isotope systematics suggest that both the host mafic granulite and SGO granulite were metamorphosed at ～1.9 Ga, and the Nd initial ratio is consistent with a MORB source at that time. There is no significant difference in the Nd values of the two rock types, suggesting that they originally belonged to the same protolith. Chemical trends within a narrow zone between the SGO and host rock granulite suggest that the former was derived from a basaltic precursor of the latter by a process of infiltration metasomatism, comparable with the chemical exchange that takes place when hydrothermal fluids in present-day oceanic crust pass through vents in a "recharge zone." The geological and chemical relations observed in the South Harris rocks are consistent with the following model: hydrothermally altered oceanic basaltic crust was trapped in an accretionary wedge and subducted, followed by granulite-facies metamorphism in a deep continental environment during arc-continent collision. This is the first report of hydrothermally altered oceanic crust that was converted to sapphirine-bearing granulite deep in the continental crust.

Size fraction and class composition of phytoplankton in the Antarctic marginal ice zone along the 140° E meridian during February-March 2003

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We investigated the size fraction and pigment-derived class compositions of phytoplankton within the euphotic zone of the Antarctic marginal ice zone between 63.3° S and 66.5° S along the 140° E meridian on two consecutive cruises in the late austral summer and early austral autumn of 2003. We observed significant temporal and spatial variations in phytoplankton size and taxonomic composition, although chlorophyll a concentrations were generally below 1 μ g l^{-1} during both

periods. Microphytoplankton (>20 μm), mainly diatoms, were prominent in the euphotic zone in the southernmost area around 66.5° S during late summer. In the rest of the study area during both cruises, the phytoplankton community was dominated by pico- and nano-sized populations(<20 μm) throughout the euphotic zone. The small-size populations mostly consisted of diatoms and haptophytes, although chlorophytes were dominant in extremely cold water (-1.5° C) below the overlying warm water around 65.5° S during late summer. From late summer to early autumn, chlorophytes declined in abundance, probably due to increasing temperature within the euphotic zone (-1 to 0° C). These pico- and nano-phytoplankton-dominated populations were often accompanied by relatively high concentrations of ammonium, suggesting the active regeneration of nutrients within the small-size plankton community

Glaciation of a mixed-phase boundary layer cloud at a coastal arctic site as depicted in continuous lidar measurements

James R. Campbell, Masataka Shiobara

>The dynamic seeding and glaciation of a mixed-phase cloud by ice crystals injected from above at Ny Ålesund, Svalbard, Norway is described using continuous lidar measurements and thermodynamic data. Glaciation of this cloud was caused by ice crystal growth and sedimentation due to the preferential differences in saturation vapor pressure over ice versus liquid water and riming. The lidar data suggest that precipitation reached the ground for nearly 4 h as a result. The symbiosis between ice and liquid water hydrometeor presence in the polar troposphere is unique. Thermal perturbations and airmass fluctuations influence microphysical cloud characteristics and radiative balance, which makes the otherwise pristine region sensitive to lower-latitude anthropogenic and biogenic influences and a focal point for observing indirect effects and their influence on climate change. The development of lidar technologies capable of continuous and autonomous measurements is yielding important datasets to study unique atmospheric phenomena.

Outline of a small unmanned aerial vehicle (Ant-Plane) designed for Antarctic research

Minoru Funaki, Naohiko Hirasawa and the Ant-Plane Group

As part of the Ant-Plane project for summertime scientific research and logistics in the coastal region of Antarctica, we developed six types of small autonomous UAVs (unmanned aerial vehicles, similar to drones; we term these vehicles 'Ant-Planes') based on four types of airframe. In test flights, Ant-Plane 2 cruised within 20 m accuracy along a straight course during calm weather at Sakurajima Volcano, Kyushu, Japan. During a period of strong winds (22 m/s) at Mt. Chokai, Akita Prefecture, Japan, Ant-Plane 2 maintained its course during a straight flight but deviated when turning leeward. An onboard 3-axis magneto-resistant magnetometer (400 g)

recorded variations in the magnetic field to an accuracy of 10 nT during periods of calm wind, but strong magnetic noise was observed during high winds, especially head winds. Ant-Plane 4-1 achieved a continuous flight of 500 km, with a maximum flight altitude of 5690 m. The Ant-Plane can be used for various types of Antarctic research as a basic platform for airborne surveys, but further development of the techniques employed in takeoff and landing are required, as well as ready adjustment of the engine and the development of small onboard instruments with greater reliability.

Nitrogen concentration within Saxifraga oppositifolia in different successional stages on a glacier foreland in the high Arctic

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We measured and compared the $\delta^{13}C$ values and nitrogen concentrations within the photosynthetic parts (Np) of phototrophs growing in different successional stages and different soil conditions at Ny-Ålesund, Svalbard, Norway. At all study sites, the Np value of vascular plants ranged from 1.0 to 2.2%. The Np value for most moss species was less than 1.0%; values for lichens were about 0.5%. No significant correlation was detected between Np and $\delta^{13}C$; however, different plant species occupied distinct fields on a $\delta^{13}C$-Np plot, with minimal overlap between species. The Np value of Saxifraga oppositifolia, which grew at all of the study sites, ranged from 1.1 to 1.5%. Differences in growth form had no effect on Np. The Np and $\delta^{13}C$ values obtained for S. oppositifolia were confined to within a narrow range regardless of site conditions.

Role of Antarctic ice mass balance in present-day sea-level change

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The Antarctic ice sheet is arguably the most critical in terms of future sea-level rise, primarily because it contains ～70% of the world's fresh water. While there exists evidence of accelerated ice-sheet ablation during the past decade, the possibility that the ice sheets contributed little to 20th century sea-level rise could result in Antarctica becoming the largest contributor to sea-level rise during the 21st century. Here we review the findings of studies published following the 2007 Intergovernmental Panel for Climate Change (IPCC) study, focusing on the role of Antarctica in present-day (1992-2006) sea-level rise. We show that the choice of glacial isostatic adjustment (GIA) model significantly affects GRACE-estimated Antarctic mass loss, adding 0.25-0.45 mm/yr to the estimate of sea-level rise. The current estimate of Antarctica's contribution to sea-level rise has a wide range: from -0.12 to +0.52 mm/yr. The discrepancy between observed sea-level trend of 1.8 mm/yr and those estimated from various geophysical sources (2.10 ± 0.99 mm/yr) is 0.30 mm/yr. The role of Antarctica in sea-level rise might be better

constrained by lengthening satellite observations, using long-term GPS data to discriminate subglacial vertical motion from ice mass balance, and detecting the sea-level signal due to elastic loading from the melting ice-sheets.