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The first "hard rock" description onboard the drilling vessel D/V *Chikyu*: a historical collaboration between the Oman Drilling Project of the International Continental Scientific Drilling Program (ICDP) and the International Ocean Discovery Program (IODP)

The drilling vessel D/V *Chikyu* ["chikyu" is Japanese for "Earth"] is the first riser drilling-equipped scientific research vessel capable of drilling up to 7 km beneath the sea bed. This is far deeper than any other scientific drilling vessel. Although *Chikyu* has successfully recovered core samples from several previous scientific targets – such as the Nankai Trough Seismogenic Zone (Araki et al. 2017), the Tohoku earthquake slip surface (Ujiie et al. 2013), and examined biomass of sub-seafloor microbial life (Inagaki et al. 2015) – she has never drilled cores from significant depth in "hard rocks".

The Oman Drilling Project (http://www.omandrilling.ac.uk/) of the International Continental Scientific Drilling Program (ICDP) aims to understand oceanic plate formation and the alteration of that plate, including active serpentinization and its relationship to the deep biosphere (Kelemen et al. 2013). During the first phase of the drilling project (late December 2016 until the end of March 2017), 1.5 km of core were obtained from four boreholes into the crustal and mantle sections of the Samail ophiolite, with 100% recovery. Three boreholes were drilled into the lower crustal section of this ophiolite (GT1, lower gabbros; GT2, foliated gabbros; GT3, dike–gabbro transition). One borehole (BT1) passed through the basal thrust from the listvenite section [listvenites being carbonated peridotites interlayered with partially serpentinized peridotites], through the fault zone, and terminated in the fine-grained mafic volcanics and sediments of the metamorphic sole. Geophysical properties and geological descriptions of the Oman Drilling Project cores were carried out for the first time on board the *Chikyu* from 15 July 2017 to 15 September 2017 by shipboard scientists from all over the world (nicknamed ChikyuOman) (Fig. 1). The analytical methods closely followed those used during IODP Expeditions 304/305, 309/312, 335, 345, and 360 by *JOIDES Resolution* and IODP *Chikyu* Expeditions 322, 348.

Figure 1 The onboard scientific party for the Oman Drilling Project, nicknamed ChikyuOman.

A series of carefully structured preparations and tests were followed on the ship. All core sections are shrink-wrapped and run through the X-ray computed tomography (X-ray CT) scanner to obtain X-ray CT images. Natural gamma radiation and magnetic susceptibility were subsequently measured using a whole-round multi-sensor core logger. The X-ray CT scan is a routine measurement used during IODP research, and it was applied to the Oman Drilling Project core on *Chikyu*. It enables the non-destructive observation of the internal structure of core samples. The X-ray intensity varies as a function of X-ray path length and the linear attenuation coefficient of the target material, which is dependent on its chemical composition and density. The X-ray CT images that are obtained can provide information on chemical compositions and densities of the cores, which can be used to assess sample locations and the quality of the whole-round samples. An example of an X-ray CT image taken from a section of Hole C5701A (Section 805-C5703A-7Z) is shown in Figure 2. Additional measurements of gamma ray attenuation density, P-wave velocity, and non-contact resistivity were also taken. Information generated from these instruments form part of the J-CORES database of the *Chikyu*-curated section lengths done for each core section. A comprehensive discussion of methodologies and calculations used in the *Chikyu* Physical Properties Laboratory (except for the X-ray computed tomography) is given by Blum (1997). In addition to these analyses, a Caltech imaging spectrometer system was used to scan the entire 1.5 km archive half of the core from all four boreholes at ~250 μm/pixel. Representative samples, and some specific samples, were subjected to X-ray diffraction analysis; X-ray fluorescence (to analyze for major, trace, and minor element concentrations); inductively coupled plasma mass spectrometry (using mixed acid/alkali-fusion digestion); loss on ignition; and an elemental analyzer (to assess volatile element concentrations of H, C, N, S). Routine shipboard paleomagnetic and magnetic anisotropy experiments were carried out within the ship's shielded room. All the data collected are being used to link together petrological observations (background characters, structure, alteration, and veins), representative thin section information, measurements made by downhole wireline geophysical logging, and regional geological survey results.

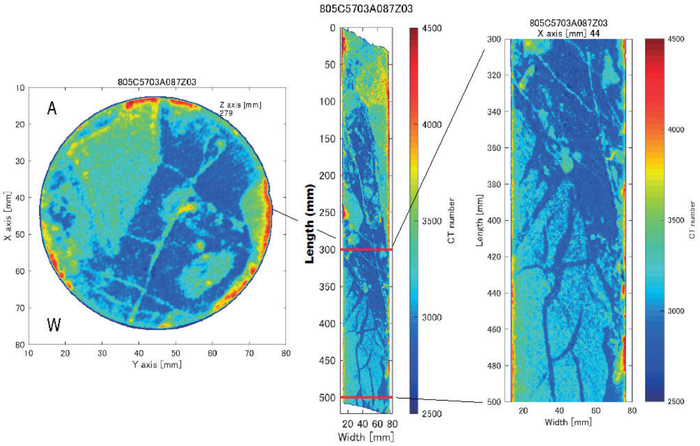

Figure 2 An X-ray computed tomography image of a magmatic breccia from an Oman Drilling Project core (Section 805-C5703A-87Z-3).

We are also pleased to announce that drilling into the crust–mantle boundary, the Moho Transition Zone (MTZ), and into active serpentinization sites of the Samail ophiolite, were completed during Phase 2 of the Oman Drilling Project. The second phase was implemented from December 2017 to March 2018. We obtained 1.7 km of core, with 100% recovery. The detailed description of the Oman Drilling Project Phase 2 core will take place on board the D/V *Chikyu* between 5 July 2018 to 5 September 2018 while the ship is docked in Shimizu (Japan). The results of the Oman Drilling Project and ChikyuOman proved that D/V *Chikyu* is ready for hard-rock drilling, necessary on the Mohole to Mantle (M2M) project which aims to drill through a complete section of oceanic crust into the underlying mantle in the Pacific Ocean (Umino et al. 2013).

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Original Articles

Dissolution of diamond crystals in a heterogeneous (metal–sulfide–silicate) medium at 4 GPa and 1400 °C – Anatoly I. CHEPUROV, Valeri M. SONIN, Egor I. ZHIMULEV, Aleksei A. CHEPUROV, Boris S. POMAZANSKY and Aleksei L. ZEMNUKHOV

Formation of triple-layer coronas between corundum and hornblende from the Lützow–Holm Complex at Akarui Point, East Antarctica – Yuki MORI and Takeshi IKEDA

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Geochemical, structural and morphological characterization of vein graphite deposits of Sri Lanka: Witness to carbon-rich fluid activity – H.P.T. Sasanka HEWATHILAKE, N.W.B. BALASOORIYA, Yoshihiro NAKAMURA, H.M.T.G.A. PITAWALA, H.W.M. Athula Chandana WIJAYASINGHE and M. SATISH-KUMAR

Letter

In situ X-ray diffraction studies of hydrous aluminosilicate at high pressure and temperature – Ryota ABE, Yuki SHIBAZAKI, Shin OZAWA, Itaru OHIRA, Hiromu TOBE and Akio SUZUKI

Laboratory measurements of electrical conductivity in a gabbro of the Oman ophiolite at high pressures and high temperatures: implications for interpretation of resistivity structures of lower oceanic crust – Satoshi SAITO and Nikolai S. BAGDASSAROV

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MINERALOGICAL DATABASES AND DATA PLATFORMS: TOOLS SUPPORTING THE SPREAD OF MINERALOGICAL KNOWLEDGE IN THE EU

Collecting data into structured databases, managing these databases, and integrating them into larger units (platforms) are practices that are becoming increasingly urgent today. This urgency is due to the increasing demand for access to various types of data by a wide range of diverse users, from scientists to political decision-makers. Harmonizing data, organizing regular updates, and guaranteeing good data quality are now the tasks of many European Union (EU) projects. Keeping mineralogical databases up-to-date is becoming increasingly important.

Of the many operating mineralogical databases, the two best-known contain basic mineralogical data such as composition, structure, and geographic occurrence: Mindat (https://www.mindat.org) and WebMineral (http://webmineral.com/). A third database, Minerant (www.minerant.org/), consists of information relevant to collectors. Mindat and WebMin support newly generated databases that cover a wide thematic range. A more specialized database dedicated to spectral data is the RRUFF Project (http://rruff.info/about/about_general.php). This project has a complete set of high quality spectral data from well-characterized minerals. It is addressed to mineralogists, geoscientists, gemologists and the general public interested in Earth sciences and planetology.

New mineral databases expand the information needed to support decision-making in regard to mineral exploration, exploitation, production, trade activity, policy, and legislation. Such databases need to provide information regarding the location and spatial distribution of minerals. Both primary and secondary minerals are objects of industry interest. Exploration and exploitation of mineral resources, as both primary and secondary deposits, are critical issues for the modern economy. Within the EU, various institutions have emerged whose aim is to provide tools that will help in mineral exploration and exploitation. One of those is GeoERA (http://geoera.eu/), which its website says means, "Establishing the European Geological Surveys Research Area to deliver a geological service for Europe (GeoERA)". GeoERA regularly announces calls for European Geological Survey research projects. These calls have included "Raw Materials Specific Research Topics" and "Improving and Sustaining the Raw Materials Knowledge Base by Periodically Delivering a Minerals Yearbook and Inventory Information System". The idea of the mineral yearbook was introduced in 1933 in the US with the publication of an annual report that reviewed minerals and materials from the US and many other countries. The European Minerals Yearbook continues this idea and develops it for European needs.

Another EU minerals platform is the European Minerals Knowledge Data Platform (EU-EMKD) (http://minerals4eu.brgm-rec.fr/). This platform is defined on their website as "A simplified, user-friendly and efficient access to all available and new data related to mineral resources through the 'Minerals4EU' Knowledge Data Platform." Indeed, the Minerals4EU project was developed to implement the EU mineral intelligence network structure in a form suited to the EU-EMKD platform, the European Minerals Yearbook, and various predictive studies.

Two other platforms need to be mentioned: the Raw Materials Information System (RMIS) (http://rmis.jrc.ec.europa.eu/) and the more versatile system that is the European Geological Data Infrastructure (EGDI) (http://www.eurogeosurveys.org), which is governed by EuroGeoSurveys. However, all these mineral platforms and databases pose something of a challenge: how can we unify them and create useful and necessary connections between them? And then, of course, how can we manage that integrated system itself?