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News and Highlights

Report on the Third IGCP-649 International Workshop on the Mayarí-Baracoa Ophiolites and Chromitites, Cuba

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During April 3^{rd}–14^{th}, the Third International Ophiolite Workshop of the International Geoscience Programme "Diamonds and Recycled Mantle" (IGCP-649) was successfully held in Havana, Cuba (Fig. 1a). After the workshop, participants participated in a field trip to the Mayarí-Baracoa ophiolites and related chromitites in eastern Cuba (Fig. 1b). This Third International Ophiolite Workshop was jointly organized by the IGCP-649 Project Team and the Cuban Geological Survey. This workshop was included in a special session of the VII Cuba Earth Science Convention. Since the 1980s, diamond, moissanite and other unusual minerals have been successively recovered from peridotites and chromitites in ophiolites of different ages and locations. Under this background, the goal of the International Ophiolite workshop is to investigate the composition and evolution of the deep oceanic mantle by studying ophiolites in different orogenic belts all over the world, and also to provide new ideas for chromitite prospecting and exploration by studying the deep-mantle origin of ophiolites and their chromitites.

About 100 scientists from China, America, Germany, Canada, Russia, Turkey, Egypt, Cuba and countries around Cuba attended this ophiolite workshop of IGCP-649. After the workshop, 40 scientists participated in the field trip to the eastern Cuban ophiolites. At the beginning of the workshop, Dr. Enrique Castellanos Abella (Director of Cuba Ministry of Energy and Mines), Dr. Kenya E. Núñez Cambra (President of Cuba Geological Society), and Dr. Angélica I. Llanes Castro (Cuba Geological Survey) made opening speeches. Angélica I. Llanes Castro and other members of the Cuba Geological Survey organized the field investigation and introduction.

During the workshop, scientists from different countries reported the research status and progress on ophiolites of different tectonic settings in different locations of the world and also discussed the problems existing in the study of ophiolites and chromitites. Manuel Iturralde Vinent from Cuba Geological Survey systematically outlined the geological evolution of Cuba and the Cuban ophiolites, from which geologists who were visiting Cuba for the first time benefited a great deal. Dr. Yang Jingsui from Chinese Academy of Geological Sciences reported the progress on the studies of diamond and other unusual minerals recovered from different ophiolites and proposed a new name of "Luobusa-type" diamond for the diamond recovered from ophiolites. The new name comes from the Luobusa ophiolite, in which such diamonds were first discovered. Michael Wiedenbeck from the German Research Center for Geosciences introduced the advanced analytical technology which can be used in the study of ophiolites and chromitites. This workshop provides an important opportunity for researchers working on ophiolites and chromitites to study and communicate with each other.

Cuba is situated in Central America and has experienced a complicated geological history, including the generation and metamorphism of oceanic crust, the growth of island arcs and the final emplacement of oceanic lithospheric relicts (Iturralde-Vinent et al., 2006). Three major ophiolite-bearing units exist in Cuba including: (1) the northern ophiolitic belt; (2) the metamorphic basement of the Cretaceous volcanic arc terrane; and (3) tectonic slices in the Escambray massif (one of the metamorphic terranes) in Central Cuba (Fig. 2a). However, over 90% of the oceanic lithosphere remnants in Cuba are included in the Northern ophiolitic belt (NOB). The NOB is mainly a large mélange that stretches 1000 km along northern Cuba, whose blocks are composed mainly of ophiolitic suite components, floating in a serpentinite matrix. The age of this ophiolitic belt is thought to be Upper Jurassic–Lower Cretaceous (Iturralde-Vinent et al., 2006). Tectonized ultramafic rocks and cumulative rocks ate the most common lithologies, whereas the basalts and sedimentary rocks are poorly exposed. Only sparse age data are available for the NOB rocks.

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Fig. 1. (a), Workshop participants at the Third International Ophiolite Workshop of IGCP-649 in Havana, Cuba; (b), Workshop participants at the field trip in the Mayarí-Baracoa ophiolites, eastern Cuba.

The Mayarí-Baracoa ophiolite in the eastern segment of the northern ophiolitic belt is the main chromitite mining area in Cuba. It is mainly composed of the Moa-Baracoa massif in the east and the Mayarí-Cristal massif in the west (Proenza et al., 1999; Marchesi et al., 2006) (Fig. 2a). The Moa-Baracoa massif crops out over an area of 1500 km^2. This ophiolitic massif is mainly composed of mantle peridotites and Moho-transition zone rocks. The Mayarí-Cristal massif is the most important high-Al chromitite mining area in Cuba, and has around 100 ore bodies. Of these ore bodies, the Mercedita chromitite is the largest, having over 5 million tons of chromitite. The Mayarí-Cristal massif crops out over about 1200 km^2. This massif is dominated by mantle peridotites with a thickness of 5 km. The Mayarí-Cristal body mainly has two high-Cr chromitite ore bodies with ore reserves of over 200 thousand tons. Both high-Cr and high-Al chromitites occur in the Havana-Matanza ophiolite of western Cuba. Metamorphic rocks including eclogite, amphibolite and antigoritite can be found in the Cuban ophiolitic belts, and these record the metamorphic history of the Cuban ophiolites. During the field trip, peridotite, chromitite, mafic dikes, cumulate gabbro, pegmatite and pillow lava in Mayarí-Baracoa ophiolites of eastern Cuba were investigated in detail. Mafic dikes in these ophiolites were sampled systematically for geochemical studies and age dating. Large amounts of peridotite and chromitite from the Mayarí-Baracoa ophiolitic belts were collected for future mineral separation and geochemical studies.

The field excursion of the Third International Workshop in Cuba lasted from April 9th, 2017 to April 13rd, 2017, and included 11 stops to view different geological phenomena. The detailed field excursion is as follows.

STOP 1-Pinalito (Mayarí-Cristal ophiolite): This area represents the southern flanks of the Mayarí-Cristal massif with outcrops of ultramafic rocks cut by silicic and mafic dikes and sills (dolerite, microgabbro, pegmatitic gabbro, diabase and quartz diorite) of controversial origin (cogenetic or not with arc volcanic). Peridotite rocks in this region are strongly serpentinized or otherwise altered. The peridotites are mainly harzburgites, with minor dunite. Pyroxenite veins are commonly observed cutting the peridotites.

STOP 2-La Picota Maastrichtian olistostrome (Mayarí-Cristal ophiolite): A steep clastogenic outcrop containing fragments and blocks mainly of mafic and ultramafic rocks is well exposed. This formation represents part of the frontal mélange during the obduction of the ophiolite. The ultramafic blocks in the olistostrome are strongly altered with yellowish-brown colors. Mafic rocks in the olistostrome are mainly gabbroic and diabasic rocks. These different rocks are mainly cemented by carbonate minerals. Olistostromes are mélanges formed by gravitational sliding under water and accumulation of flow as a semi fluid body with no bedding.

STOP 3-Casimba high-Cr chromite mine (Mayarí-Cristal ophiolite): An open quarry through the lateritic cover containing disseminated, massive and nodular chromitites within dunites. This mine was partially exploited before 1959 and now has around 120,000 t of chromitite with chemical compositions (wt.%) of Cr_2O_3=25.94–28.64, Al_2O_3=4.84–13.51, FeO=6.74–7.31, Fe_2O_3=0.87–7.18, SiO_2=16.08–17.5. Silicate minerals in the chromitite of this quarry are relatively strongly altered to serpentine and magnesite. Dunitic envelopes are commonly observed surrounding chromitites. The country rocks of these chromitites are harzburgites. The chromitites are mainly disseminated varieties associated with dunites.

STOP 4-Guamuta (Mayarí-Cristal ophiolite): Microgabbro massif and dolerite dikes in a broad alteration zone in the western flanks of the ultramafic rocks. The peridotites are dominated by serpentine minerals (80wt.%–85wt.%), with minor chlorite and carbonate minerals. On the basis of major and trace element components, the dikes are suggested to represent arc tholeiite of a sub-volcanic complex (Marchesi et al., 2007), whereas it has been previously reported as sheeted dykes (Fonseca et al., 1985).

STOP 5-Juanita (Mayarí-Cristal ophiolite): High-Cr chromitite and country rocks. High-Cr chromitites in this stop have variable textures including nodular, densely disseminated and massive (Fig. 2b).The chemical compositions of chromite in the chromitites vary with the different textures and have chemical compositions (wt.%) of Cr_2O_3=36.95–47.05, Al_2O_3=9.71–11.87, FeO=0.72–11.23, and SiO_2=6.38–12.6. The country rocks of the chromitites are mainly strongly serpentinized harzburgites. Dunitic and pyroxenitic veins are commonly observed in the harzburgites. These veins are generally 2–3 cm in wide. Dunitic envelopes occur between the chromitites and harzburgites.

STOP 6-Arroyo Seco (Mayarí-Cristal ophiolite): A unique occurrence of high-Al chromitite in the Sierra de Nipe massif. It is ~3 km to the NE of the high-Cr Juanita mine and is surrounded by other high-Cr deposits, such as the Victoria and Cuchita, etc. The chromite ores have nodular, massive and disseminated textures. Dunite envelopes exist between the chromitites and the harzburgites. Chromites in high-Al chromitites have chemical compositions (wt.%) of Cr_2O_3= 30.42–36.96, Al_2O_3=21.17–21.65, FeO=10.52–12.36, Fe_2O_3=13.10–14.81, SiO_2=6.90–11.92, MgO=20.77–18.27 and CaO<0.1.

STOP 7-Caledonia (Mayarí-Cristal ophiolite): High-Cr chromitites and country rocks.This chromitite body is the largest metallurgical chromite mine in this district (and one of the geological patrimonies of Cuba). A large pile of chromitite with different textures (nodular, massive and disseminated) can be observed. By the ravine walls and the brook line, we can see good exposures of the wall rock (peridotites, pyroxenite cutting dikes, the layering, etc.). This mine was exploited until 1949 and over 200,000 t of high grade metallurgical chromite ores were extracted

Fig. 2. (a), Geological sketch of Cuba showing location of the northern ophiolite belt and other important geologic elements mentioned in the text (after Iturralde-Vinent, 1998); (b), Nodular chromite ores in high-Cr chromitite; (c), Cumulative gabbros showing clear layered texture; (d), Chromitites occur as xenoliths in the pegmatite; (e), Ultramafic cumulates with quartz gabbros and pegmatitic gabbros in the Mayarí-Baracoa ophiolites.

from it with 9000 t left. Chromites have chemical compositions (wt.%) of Cr_2O_3=31.94–48.03, Al_2O_3=8.04–11.06, FeO=9.81, SiO_2=9.01–15.0, MgO=20.0 and CaO=1.04. The foliation of the harzburgite extends to the NE and dips 30º NW.

STOP 8-Loma de la Bandera (Mayarí-Cristal ophiolite): Mafic-ultramafic outcrops with pegmatitic gabbros and diabase dikes cutting the peridotites.

STOP 9-Quemado del Negro (Moa ophiolite): Mafic cumulate rocks. The mafic cumulates are olivine-bearing metagabbros composted of bytownite-labradorite with poikilitic inclusions of serpentinized olivine, clinopyroxene (augite), and with sulphide mineralization <1%. These cumulate rocks show clear layered textures indicative of a cumulative origin (Fig. 2c).

STOP10-Cayo Guam-Cromita (Moa ophiolite): High-Al chromitite. This chromitite body is the largest deposit of refractory chromitite in the Moa-Baracoa district. The chromitites mainly have nodular, banded, massive and dense-disseminated textures. Gabbroic pegmatite boulders are commonly found along the riverside in this region. These pegmatites are composed of macro-crystals of pyroxene and plagioclase. The pyroxene and plagioclase crystals can be more than 15 cm long. The pegmatite boulders are closely associated with the chromitites. Some chromitites occur as xenoliths in the pegmatite (Fig. 2d). The chromitites generally have sharp contacts with the pegmatites. Silicate minerals in the chromitite are completely altered to white magnesite.

STOP 11-Yaguaneque (Moa-Baracoa ophiolite): Ultramafic cumulates with quartz gabbros and pegmatitic gabbros (Fig. 2e). The ultramafic cumulates are moderately weathered and are cut by several generations of quartz gabbro and pegmatitic gabbro. The ultramafic cumulates have massive and banded textures, characterized by brown, olive green or red colors. The ultramafic cumulates are mainly composed of olivine (Fo=90–80), orthopyroxene (En=89–78) and clinopyroxene (augite).

Introduction of IGCP-649 Project

IGCP-649 is a global research programme, undertaken by the Center for Advanced Research on the Mantle (CARMA), Institute of Geology, Chinese Academy of Geological Sciences. This project is conducting extensive and systematic research on peridotites, chromitites and related materials (diamond, moissanite and other unusual minerals) from different ophiolites in global orogenic belts, to better understand new scientific problems such as the formation and origin of deep-mantle minerals in oceanic lithosphere, the origin of carbon for the “Luobusa-type” diamonds, the evolution of Earth’s mantle and the dynamic process of ophiolite emplacement. IGCP-649 project, which will last for five years (2015–2020) was financed and sponsored by UNESCO and IUGS. In August of 2015, the First Ophiolite Workshop was held in Xining of Qinghai Province, China. After the workshop, participants undertook a field trip to investigate the Early Paleozoic ophiolite and high-pressure metamorphic belt in the QilianMountain. The Second Ophiolite Workshop was held in Cyprus in May of 2016. And it included a field trip to investigate the world-renowned Troodos ophiolite (Yang Jingsui et al., 2016). This project is led by an international team of researchers, including Prof. Yang Jingsui of Institute of Geology of CAGS (China), Prof. Yildirim Dilek of Miami University (USA), Prof. William L Griffin of Macquarie University (Australia), Prof. Paul T. Robinson of Dalhousie University (Canada), Prof. Ibrahim Milushi of Polytechnic University of Tirana (Albania), and Prof. Mohamed Metwaly Abu Anbar of Tanta University (Egypt).

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