



Preface

Blueschist- to eclogite-facies rocks: from HP to UHP

Impressed by the beauty of a metamorphic rock from the Saualpe, Austria, René-Just Haiiy (1743–1822) created the name “eclogite” (the chosen rock), which he derived from the Greek word εκλογή (choice). The name was used for the first time in 1822 in the second edition of Haiiy's “Traité de minéralogie”. However, the first “scientific” description dates back to the second half of the 18th century, when Horace-Bénédict de Saussure (1740–1799) mentioned a “beautiful rock that is not described yet” from the Rhône Valley in his famous book “Voyages dans les Alpes”. Eclogite is a metabasic rock dominated by the minerals omphacite and garnet, and in the 20th century eclogite was recognized as a high-pressure (HP) metamorphic rock. Concurrently, it was discovered that metabasic blueschist, dominated by blue sodium-rich amphiboles, represented another HP metamorphic rock formed at lower metamorphic grade than eclogite. Then, in the mid nineteen-eighties, metamorphic coesite (and somewhat later even diamond) was discovered in eclogite-facies rocks, indicating pressures even higher than had been considered possible up to that time. The term “ultrahigh-pressure (UHP) metamorphism” was born. The term describes metamorphism at depths corresponding to pressure–temperature conditions exceeding the lower limit of the coesite stability field. The significance of UHP metamorphism is most striking for rocks that initially formed in the crust and were then subducted to UHP conditions, but our understanding of mantle processes has been enriched through study of mantle-derived garnet peridotites at UHP conditions as well. These findings generated numerous new research projects with enormous implications for petrology, geodynamics, global tectonics, seismology, and geochemical recycling.

This special issue contains a selection of contributions which were presented at the 11th International Eclogite Conference (IEC), in accordance with the theme “Blueschist- to eclogite-facies rocks: from HP to UHP”. The meeting took place near Rio San Juan on the northern coast of the Dominican Republic between January 31 and February 7, 2015 (see Klemd, Elements, v. 11, p. 288, 2015). The first IEC was organized in 1982 in Clermont-Ferrand, France, and was the result of dramatically increased interest in HP and UHP metamorphism; presentations included studies on natural samples, high-pressure experiments, and computer modelling. Since then the IEC has been an important event with an international reputation, initially held every four years. At irregular intervals, “International Eclogite Field Symposia” were organized in between. At the beginning of the 21st century, it became clear that the tenor of both the IECs and the International Eclogite Field Symposia were converging more and more. Consequently, in 2007 it was decided during the business meeting of the International Eclogite Conference Co-ordinating Committee (IECCC) in Seggau, Graz (Austria), that, beginning with IEC-8 in Xining (China), the meetings should take place every two years as IECs. The host of the upcoming IEC-12 will be Sweden in 2017. Following tradition, the program will include several field trips. A three-day pre-conference field trip will lead to Jämtland (Seve Nappe Complex) in the Swedish Caledonides, where evidence of UHP metamorphism has recently been found in eclogite, garnet pyroxenite and paragneiss. A one-day mid-conference field trip during the subsequent four-day meeting will present newly discovered diamond-bearing UHP-metamorphic rocks, and the three-day post-conference field trip will lead to the classical HP and UHP rocks of the Western Gneiss Region in Norway. Details are available at www.geology.lu.se/IEC12; for general information on the IECs see www.rub.de/eclogite.

The IEC-11 in Rio San Juan represented the very first such meeting to be held in the “New World”. Forty-eight talks and 41 posters were presented during three days of auditorium conference sessions. The meeting provided an opportunity to welcome close to 100 participants from almost two dozen countries, and to introduce them to a “new world” of HP-UHP rocks during lectures, posters and especially during conference field-trips. The latter illustrated the variety of (U)HP, subduction-related rocks representative of the fossil subduction-zone complex exposed on Hispaniola. A pre-conference field trip focused on the serpentinite mélanges of the Rio San Juan Complex, which are interpreted to represent the former subduction channel of an intra-oceanic island arc that has been moving eastward relative to the Americas for more than 100 million years, and which is today represented by the Lesser Antilles Island Arc. Highlights in the field were different kinds of jadeitites and jadeite–lawsonite rocks, blueschists, eclogites and serpentinites. During a syn-conference field trip, participants visited the excavation site of a pre-Columbian Taíno village, where a multitude of jadeitite artefacts have been found. During a post-conference field trip, the (U)HP eclogites, garnet peridotites and associated enigmatic rocks from Las Cuevas of the southern Rio San Juan complex led to debates on the exhumation mechanisms necessary for such a rock inventory within an intra-oceanic environment. A final day was devoted to mélange-like outcrops of blueschists and eclogites within a metasedimentary matrix dominated by marble exposed directly along the picturesque rocky seashore of Samaná Peninsula, considered by many participants to represent a “textbook locality”.

In keeping with the multinational character of the meeting, presentations covered a spectrum of case studies spanning the entire globe. The papers in this volume mirror this diversity. However, we have organized them to reflect the guiding theme of the meeting: “Blueschist- to eclogite-facies rocks: from HP to UHP”.

Sato et al. studied a blueschist occurrence in the Kurosegawa belt, Kyushu, Japan, where the progressive transition from pumpellyite- to lawsonite-bearing rocks is exposed. The transition reflects a pressure-dominated hydration-reaction sequence from 5 to 7.5 kbar at 200–300°C. The authors derive a petrogenetic grid for these P–T conditions and document an increase with P in total stored H₂O content from 3.6 wt% to 5.0–6.4 wt%. Majka et al. focus on blueschists from the Kopina Mt. in the Western Sudetes of the Northern Bohemian Massif, Poland. The authors demonstrate on the basis of P–T pseudosection calculations that the rocks experienced maximum P–T conditions of about 12–15 kbar at 480–520°C, which are considerably higher than previously reported. These peak conditions indicate a low-temperature geotherm of 8–10°C/km. The rocks are interpreted to derive from a distal part of a continental margin. Willner et al. show that realistic isochemical “pseudosection” model calculations are possible at 300 to 400°C in a study of a blueschist–greenschist sequence of major regional importance on the Island of Jamaica. The sequence is interpreted to show a metamorphic field gradient in a former accretionary complex of the Cretaceous Caribbean intra-oceanic island arc system. Meng et al. report new geochemical data and Sr–Nd isotopic compositions of jadeitites from the Syum-Keu complex, Polar Urals, Russia, as well as REE Hf–O isotope data on the associated zircons, in order to constrain the source of the jadeitite. The authors conclude that the jadeitite was precipitated from fluids interacting with mafic-ultramafic rocks in a subduction-zone environment, but that the zircons were physically acquired from precursor igneous rocks.

Lombardo et al., in tribute to Bruno Lombardo who passed away in 2014, present geochemical data and U/Pb SIMS (secondary ion mass spectrometry) zircon data from the first eclogites discovered in the Eastern Himalaya. Petrie et al. present the first quantitative P–T path for eclogites in the St Cyr region, Yukon, demonstrating subduction of eclogites within a coherent slab to peak conditions of 20 kbar and 670°C between 267 and 271 Ma. The work successfully documents the importance of incorporating variable oxidation states of Fe in isochemical phase equilibrium models. Li & Massonne studied an eclogite body and its adjacent orthogneiss from the Malpica Tuy zone in NW Spain and are able to improve significantly our understanding of the Early Variscan collision event that led to HP metamorphism. The authors show that the eclogite was subducted to much greater depths (ca. 80 km) than the orthogneiss; both rocks shared a common exhumation path for only the last 45–50 km. Rehman et al. apply the electron backscattered diffraction (EBSD) method to establish crystal preferred orientations (CPOs) for eclogites of the Sanbagawa metamorphic belt, Japan, and examine rheologic variations observed between two eclogite types with varying P–T conditions. Maldonado et al. studied a garnet–chloritoid–paragonite metapelite from the Chuacús Complex in Central Guatemala. They were able to define two stages of the P–T path close to peak metamorphic conditions (i.e., 20–21 kbar/500–540°C and ca. 20 kbar/580–600°C), as well as a late-stage heating event at 7–8 kbar/590–620°C. The results contribute to a better understanding of the thermal structure of the subduction zone along the southern margin of North America in the Cretaceous. Massonne applies detailed petrology, thermodynamic modeling, and electron-microprobe monazite dating to interpret a history of early LP/HT metamorphism, Eocene HP metamorphism, and retrograde andalusite growth in a metapelite from the western margin of the Rhodope Metamorphic Complex.

Zhang et al. apply zircon and rutile U–Pb geochronology of Kokchetav eclogite and whiteschist to interpret that ages of UHP metamorphism and exhumation in the less-studied coesite-bearing domain are nearly the same as those in the well-studied diamond-bearing domain, even though the two domains record different peak P–T conditions. A paper that brings together different disciplines in science is presented by Groppo et al., who studied quern stones excavated in the southern part of the Dora-Maira Massif. These stones contain coesite, but show a P–T path very different from the classical one derived for the UHP Brossasco-Isasca Unit of the Dora-Maira Massif. Most likely this material belongs to a tectono-metamorphic unit that has yet to be discovered. Konopelko & Klemd apply geochemistry and zircon geochronology to interpret Neoproterozoic sedimentary deposition and mafic dike intrusion in a rift or continental slope environment, followed by 500–475 Ma (U)HP metamorphism in the Makbal metamorphic complex of Kyrgyzstan. Schertl & Hammerschmidt studied distinct generations of white mica from the Dora-Maira UHP rocks using the multigrain stepwise-heating method, in order to understand the behavior of excess argon during sequential P–T stages of exhumation from >35 to less than 5 kbar. Excess argon is a major factor down to pressures of 10–5 kbar, and even micas formed during retrograde overprinting are affected. Even “perfect” plateau ages may represent geologically meaningless ages.

We would like to thank Reto Gieré, Christian Chopin, and Klaus Mezger for their help, patience, and constructive discussions. The current issue gained a lot from the very careful work of dozens of reviewers, and a sincere thank you is due to all of them. Without their input it would have been impossible to realize a project such as this.

H.-P. SCHERTL, Ruhr-University Bochum,
Germany (IEC president 2015–2017)

W.V. MARESCH, Ruhr-University Bochum, Germany

W.C. McCLELLAND, University of Iowa, IA, USA

C.G. MATTINSON, Central Washington University, WA, USA