The 2004 ICDP Bosumtwi impact crater (Ghana) drilling project: A review

FERRIERE, L., & KOEBEL, C.

Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria;
ladovic.ferriere@univie.ac.at; christian.koebel@univie.ac.at

The 1.07 Ma, 10.5-km-diameter Bosumtwi impact structure in Ghana is a well preserved, complex impact crater with a pronounced rim and a small central uplift (e.g., 1). Two drillholes (LB-07A and LB-08A) were drilled in the deep crater crust (up to 545.1 m below lake level) and on the outer flank of the central uplift (between 235.6 and 451.3 mbl), respectively, as part of the 2004 International Continental Scientific Drilling Program (ICDP) project [2]. The uppermost 25 m of drillcore LB-08A is composed of polymict lithic impact breccia intercalated with suevite units, whereas the lower part is composed of fractured/breciaceous metasediment between 262 to 451 mbl, dominated by meta-graywacke units alternating with phylite and slate and intersected by a few suevite dikes [3]. The suevites have a fine-grained, fragmented matrix and contain a variety of lithic clasts. Shock deformation in the suevites includes planar deformation features (PDFs) in quartz (1 to 3 sets), rare diaplectic quartz glass, and melt particles, indicating derivation from the 30-50 GPa shock zone of the transient crater. Target components forming the suevites show heterogeneous shock levels resulting from mixing during excavation and deposition of the breccia. The upper 25 m of the core most likely represents fallback impact breccia, overlaying shocked and uplifted basement rocks [3]. Suevites from borehole LB-08A differ in their petrographic characteristics from suevites outside of the crater rim, mostly in term of amount of melt and glass, a lot more abundant in the fallback suevite (i.e., suevite from outside the crater). The metasediment bedrock is mainly composed of shocked meta-graywacke containing quartz grains with planar fractures (PFs; usually 1 set) and PDFs (1, 2, or rarely 3 to 4 sets). Based on PDF set orientations and on the presence of multiple sets of PDFs in quartz grains, we estimate that the core basement section experienced peak shock-metamorphic pressures up to ~25-30 GPa. The number of shocked quartz grains decreases with increasing depth, and there is a slight decrease of the abundance of PDF sets per grain with depth. The distribution of shocked quartz grains through the basement reflects the variation of shock pressure in the uppermost part of the central uplift. We estimate that the amount of shock-wave attenuation through the core part of the uplifted target was not very strong (probably less than ~5 GPa). Additionally, as at the Ries crater (Germany), it seems that the more highly shocked/melted material is ejected/deposited outside of the crater.

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Thermobarometry and Ti-phase petrology of high-P amphibolites from the Texel Complex, (South-Tyrool, Italy)

TRIBUS, M., & TROPPER, P., & HAHIL, G.2

Institute of Mineralogy and Petrography, Faculty of Geo- and Atmospheric Sciences, University of Innsbruck, Innrain 52, A-6020 Innsbruck, Austria; Martina.Tribus@studentuibk.ac.at,
Peter.Tropper@uibk.ac.at

This study area is part of the Austroalpine Osztal basement unit and is situated in the Sprenser Valley (S-Tyrool) in the Texel Complex. The polymetamorphic basement rocks of the area to the SE of the Osztal complex have been overprinted by a HP-metamorphic event in the Cretaceous and were interpreted as part of the "Eo-Alpine High Pressure Belt". The Texel Complex is composed mainly of paragneisses with minor intercalations of microclasts, orthogneisses bodies, amphibolites and eclogites.

The amphibolites contain the mineral assemblage amphibole + plagioclase + garnet + clinopyroxite/ epidote + quartz + titanite + ilmenite + rutile + apatite + calcite. Chemical zoning in plagioclase and amphibole shows two main growth stages: an older P-dominated stage and a younger amphibolite-facies stage. The core of the amphibolites shows harzburgite composition, the rim can be chemically classified as hornblende, edenite, tschermakite and paragonite. Amphibole-inclusions within garnet as well as rims of amphiboles in the matrix show identical compositions. The chemical zoning shows decreasing Na[B]-contents and increasing Ca[B]-contents from core to rim. The decreasing glauconephene substitution (Na[B]Al[ Si]2O_{[6]} = Ca[B]Al[ Si]2O_{[6]}) and the increasing edenite (Na[Al]SiO_{[4]} = [A]si[ol]2O_{[4]}) and tschermakite (Mg[Si]2O_{[4]} = Al[Si]Al[ Si]2O_{[4]}) substitutions in the rim indicate a decrease in P contemporaneous with an increase in T.

Application of the garnet-hornblende thermometer and the garnet-plagioclase-hornblende barometer yields temperatures between 551°C and 667°C at pressure ranging from 0.80 - 1.25 GPa. Thermobarometric calculations with multi-equilibrium thermobarometry yield pressures of 0.98 - 1.17 GPa and temperatures of 600 - 654°C for the same samples. Based on the Zr-in-rutile thermometer T of 575 - 591°C were obtained. Thermometric calculations using the Ti-content in amphibole shows slightly increasing T from core (656°C) to rim (679°C). These data are in agreement with thermobarometric estimates from eclogites from the Saltau Alps nearby and thus the amphibolites reflect an early, P-accentuated, stage of Eo-Alpine decompression.

The observation of the growth sequence of the Ti-phases such as ilmenite = rutile = titanite also allows to put constraints on the P-T paths, obtained from these rocks. Calculations of model reactions in the system CaO-FeO-TiO2-Al2O3-SiO2-H2O and considering the mineral assemblage amphibole + plagioclase + clinopyroxite + quartz + garnet = rutile + ilmenite = titanite yields constraints on the transitions rutile = titanite, ilmenite = rutile and ilmenite = rutile = titanite. These calculations indicate that rutile is not always the high-P phase and that titanite has a large stability field which also extends to up to high-P conditions. Ilmenite by itself though, always seems to be associated with low-P.

Multi-equilibrium thermobarometry of eclogites from the Texel Complex, (South-Tyrool, Italy)

TRIBUS, M.1, Tropper, P., & HAHIL, G.2

1 Institute of Mineralogy and Petrography, Faculty of Geo- and Atmospheric Sciences, University of Innsbruck, Innrain 52, A-6020 Innsbruck, Austria; 2 Department of Geodynamics and Sedimentology.