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SHOCK PETROGRAPHY AND GEOCHEMICAL STUDIES OF ROCKS FROM THE WOODLEIGH (AUSTRALIA), CHESAPEAKE BAY (USA), EL´GYGYTGYN (RUSSIA) IMPACT STRUCTURES AND VARIATION IN CHEMICAL COMPOSITION IN AUSTRALASIAN TEKTITES FROM DIFFERENT LOCALITIES OF VIETNAM

by

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Abstract

This thesis presents the results of shock petrographic studies of rocks from the Woodleigh (Australia), Chesapeake Bay (USA), and the El`gygtygn (Russia) impact structures. Also included are the results of a comparative study of chemical compositions of Australasian tektites from different localities of Vietnam.

Petrographic studies of 11 thin sections from the Woodleigh impact structure, obtained from the Woodleigh 1 drill core between 194.5 to 272 m, depth have provided for the identification of planar deformation features (PDFs). The purpose of this study is to provide supportive evidence for the shock pressure involved, by measuring crystallographic orientation of PDFs with universal stage (U-stage). Shock metamorphosed effects in the Woodleigh structure include multiple sets of (PDFs), diaplectic glass (in quartz and feldspar), and kink bands in biotite. All thin sections examined display the PDF deformation phenomenon. Abundant PDFs in quartz, in addition to diaplectic glass and isotropization, are the main shock deformation effects observed in this study. The measurements of the crystallographic orientation of PDFs showed the occurrence of the shock characteristic rational crystallographic planes, {10-13}, {10-12}, {11-22} and {10-11} with a dominance of the {10-13}, and {10-12}orientations. These features provide conclusive evidence that rocks and minerals at Woodleigh structure have undergone shock metamorphism; which are generally taken to indicate average shock pressure on the order of 15 to 25 GPa. Moreover, the abundance of diaplectic quartz and/or feldspar glass displayed by some samples requires shock pressure around 30 to 35 GPa.

Shock petrographic studies were conducted on impact rocks from the Chesapeake Bay impact crater from four different drill cores. These cores were taken from Exmore, Windmill Point,

Kiptopke, and Newport News; these have penetrated into the Exmore breccia. More than 50 thin sections collected from 4 drill cores of the Chesapeake Bay crater were examined for the presence of distinct mineral deformation features. The numbers of the shocked fragments found in the thin section is relatively variable in each sample suite, where a limited number of shocked grains was identified from all the analyzed samples of this study. Shock metamorphism in Chesapeake Bay samples is manifested by a number of quartz grains with single and occasionally with multiple sets of PDFs. Up to to three sets of PDFs with characteristic crystallographic orientation were found in quartz and feldspar grains. The PDFs in the shocked quartz were found to occur in intersecting sets of planes corresponding to specific crystallographic orientation with {10-13}, {10-12}, {10-11} and {21-31}. These planes are indicative of moderate shock pressures.

The 18 km diameter El`gygytgyn impact crater, Chukotka (Russia), is the only currently known impact structure formed in siliceous volcanic, including tuffs. Shock metamorphism of siliceous volcanic rocks were studied by investigations of the progressive shock-induced changes in quartz and feldspar phenocrysts and clasts of porphyritic volcanic rocks and tuffs. The stages of shock metamorphism of volcanic rocks and tuffs observed range from weakly shocked rocks to partially and completely melted rocks.

One hundred thirteen tektite samples collected from different localities of Vietnam (Hanoi, Vinh, Dalat and Saigon), were studied for their major and trace element composition using instrument neutron activation analysis and electron microprobe analysis. The main objective of the study was to determine the variation in chemical composition, and to compare their chemical variation with other Australasian tektites. The results were statistically treated for significance in the element abundances and their variation with each other and with other Australasian tektites. The tektites of this study are classified in to two groups based on their appearance and chemical variation: Splash-form and Muong Nong-type. The splash-form are usually spherical, tear-drop, dumpbell, and disc shaped with pitted or grooved surface and slightly lower silica contents from 69.7 to 76 wt.%, whereas Muong Nong-type tektites are considerably larger than splash-form and are blocky and chunky appearance with higher silica contents in the range 74 to 80.85 wt.%. The major elements of all samples show an inverse correlation with the SiO_2. Correlation coefficient have been calculated for each tektite group of this study. Many chemical similarities are noted between Hanoi and Vinh tektites, from the North of Vietnam and between Dalat and Saigon tektites. Tektites found in the North Vietnam (Hanoi and Vinh) are recognized by higher contents of Na_2O, K_2O and CaO, where as tektites found in the South Vietnam (Dalat and Saigon) are rich in MgO, FeO, Cr and Ni. The major elements of the tektites from Hanoi, Vinh, Dalat and Saigon are almost similar in composition with the average splash-form of indochinites. Similarly the average major element composition of the Muong Nong-type of this study closely resembles those of Muong Nong-type indochinites, indicating that they were derived from rocks of similar composition. However, the high-Mg tektites, high-Ca philippinites and high-Ca australites from data of CHAPMAN & SCHEIBER (1969) are distinctly different from the Vietnam tektites (this study) being higher in MgO and CaO, respectively compared to the tektites of this study. The trace element ratios Ba/Rb, Th/Sm, Th/Sc and the rare earth element (REE) contents of tektites of this study are similar to the average upper continental crust.