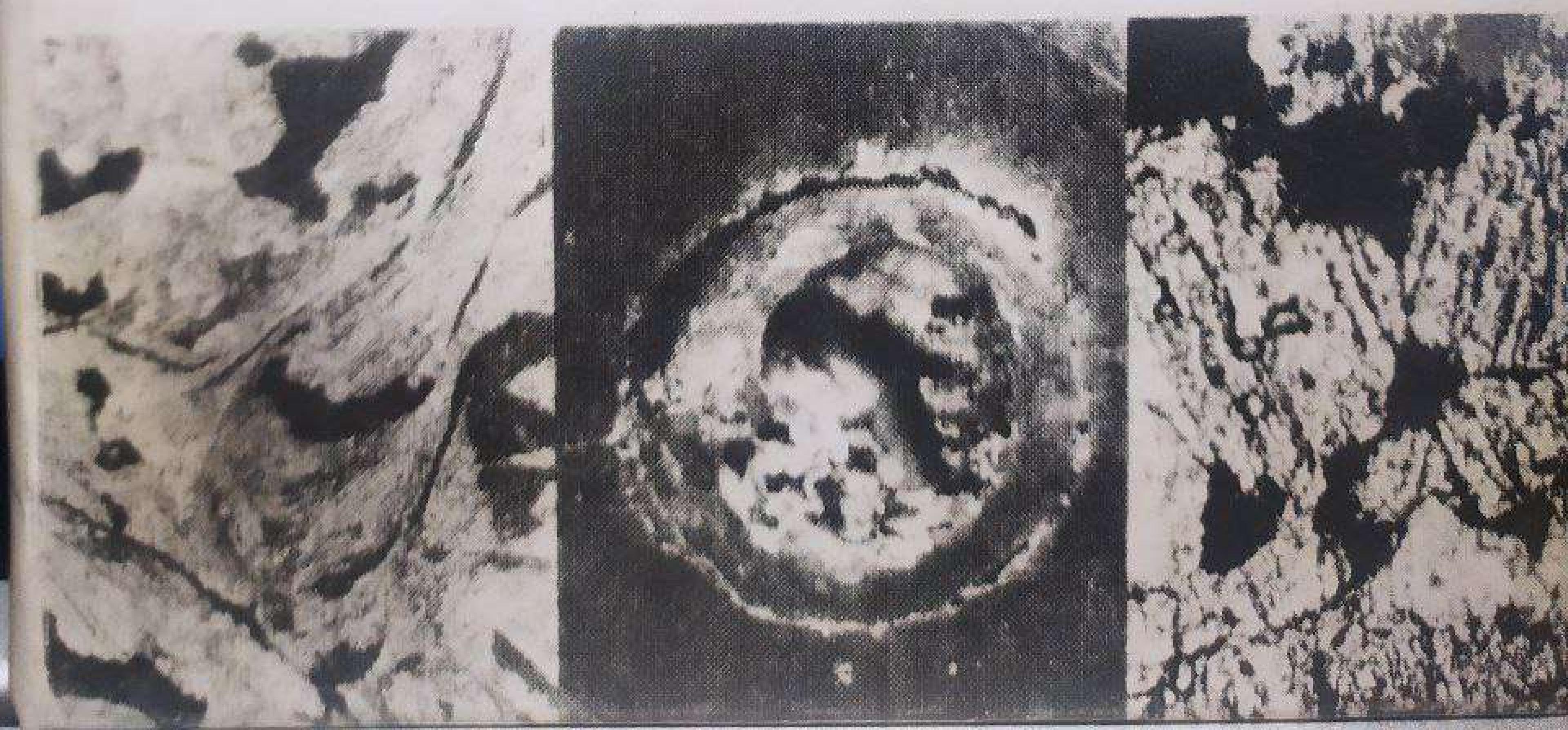
METALS AND MINERALS RESEARCH IN SPHERICAL SHOCK-WAVE RECOVERY EXPERIMENTS



Russian Federal Nuclear Center —

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ON NEW EXPERIMENTAL POSSIBILITIES IN STUDYING POLYMORPHIC AND PHASE TRANSITIONS, SOLID–STATE CHEMICAL REACTIONS IN MINERALS AND ROCKS*

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This paper describes the experimental set–up and presents results of first experiments on loading balls of solid polycrystalline α–quart (quartzite) by spherically converging waves [1] with the creation of pressures from ~ 200 kbar on the surface of recovered samples up to ~ 5–10 Mbar and up to ~ 10^4 K temperature in the ball center at 0.5–2 μs duration of the loading pulse.

Before explosive loading the samples under investigation presented 48 mm diameter balls welded in vacuum into the spherical tight gaskets of 12C18N10T steel or D–16 grade aluminium alloy. During and after explosive loading the gaskets retained strength and tightness. Calculated change of pressure in time on the external boundary of a steel (1) and aluminium (2, 3) gaskets for spherical systems having 3 times difference in size (1, 2, and 3) is shown in Fig.1a. Calculated estimations for changes in pressure and specific internal energy along the radius on the front of the spherically converging shock wave in quartzite, for corresponding conditions of its shock–wave loading, are given in logarithmic coordinates in Fig.1 b and c.

Occurrence of three concentric zones (Fig. 1d) was discovered in the equatorial plane of the quartzite ball with 47.8 mm initial diameter after loading according to the first mode illustrated in Figs.1a–c.

Formation of the destructed and pressed light mass of caked–snow type similar to that observed in meteorite craters [2] was registered at $7.5 < r < 24.4$ mm ($170 < P < 350$ kbar). In the initial state quartzite was of gray colour. Within $3.4 < r < 7.6$ mm range ($350 < P < 600$ kbar) quartzite underwent transformation into the gray semitransparent glassy phase (diaplectic glass) apparently remaining in the solid state during transformation. At $r < 3.4$ mm ($P > 600$ kbar) a dark transparent lechatelierite was formed due to vapour condensation and high–rate cooling of melt. Just in this zone effects of shock wave spherical convergence are most evident.

Experimentally demonstrated possibility to observe various stages of shock metamorphism of substance under controlled conditions within one sample investigated opens new perspectives in studying physicochemical transformations of various minerals and rocks conditioned by the impact of high pressures and

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temperatures. Transition to large-scale systems will enable the realization of substance states characteristic of small-scale systems, including extreme ones, at greater radii and with longer duration of loading pulse.

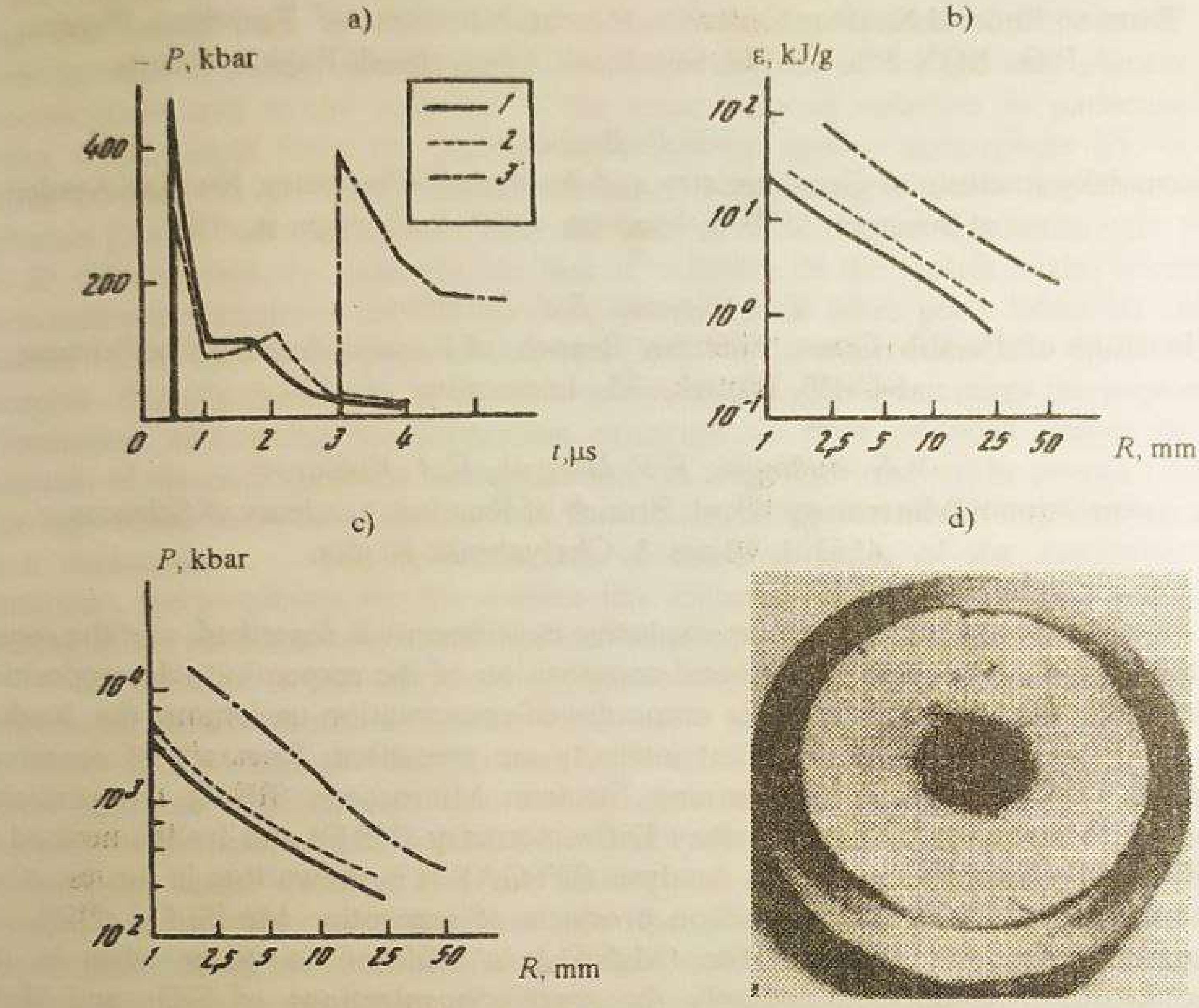

Fig. 1

Calculational and theoretical determination of parameters for a spherically converging and diverging wave formed after the converging wave focusing in the ball center anticipates the further improvement of equations of state for minerals and rocks in order to take into account all studied peculiarities of their behaviour in dynamic processes.

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