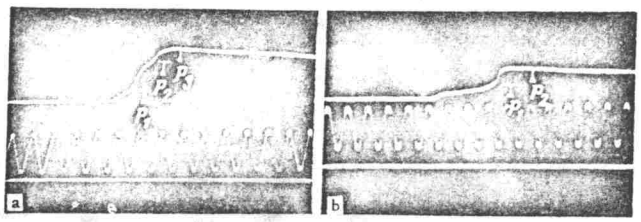

Fig. 2. Shock wave front profiles in CaF_2 and BaF_2:
a) CaF_2: P_1 = 64 kbar, P_2 = 200 kbar, P_3 = 280 kbar;
b) BaF_2: P_1 = 85 kbar, P_2 = 178 kbar. The frequency of the sinusoidal scale mark is 5 mHz.

initial density ρ_0=2.3 g/cm^3 were used to obtain a substantial increase in the temperature of the compressed specimens [13].

Structural analysis of the preserved specimens was carried out on a unit of the URS-55 type by two methods. In the first, monocrystal samples preserved after shock compression were subjected to X-ray diffraction analysis by the Laue method in an RKSO-2 chamber [14]. An X-ray tube with a molybdenum anode was used as the radiation source. The operating regime of the tube (voltage 45 kv, anode current 10 ma) made it possible to obtain a combined spectrum of bremsstrahlung and characteristic X-rays. Such a spectrum makes it possible to record on the diffraction patterns, along with the Laue reflections, reflections from the preserved monocrystal and the Debye rings from the polycrystalline phase during its formation in shock-compressed specimens. The appearance of Deby rings on the X-ray diffraction patterns of shock-compressed monocrystals is a result of the diffraction of the characteristic radiation either on the polycrystals of the initial phase formed as a result of the inverse transition of the high-pressure phase in rarefaction waves [14] or due to high residual temperatures, or directly on the polycrystals of the metastable high-pressure phase.

Figure 3 shows a typical X-ray diffraction pattern from this series of experiments, on which both kinds of reflection — highly altered as a result of asterism (stretched out radially), Laue spots, and Debye rings — are clearly visible. The latter were registered in all series of experiments with specimens of CaF_2 and BaF_2 except for fluorite, which is compressed at t = +20°C by shock waves with maximal pressures of 120 and 200 kbar, and in the majority of cases corresponded to reflections from the polycrystalline fractions of the original structure. Note also that asterism of the Laue spots was recorded in all experiments including those with maximal loads of 500 kbar. This is an indication of incomplete phase transition of the matter in the shock wave (part of it remains in the initial fluorite structure).

In addition to studies using the Laue method, specimens were subjected to X-ray diffraction in an RKD diffraction chamber of diameter 57.3 mm. The characteristic radiation of a copper anode ($\lambda K\alpha$=1.5405 Å) was used as the radiation source. The specimens were prepared in the form of columns of diameter 0.5 and height 5 mm made out of crushed monocrystals preserved after explosive compression. Figure 4 shows diffraction patterns of the original CaF_2 specimen and the same specimen compressed under pressures of 200 kbar at an initial temperature of -150°C. Alongside the lines of the initial phase on the diffraction pattern of the compressed specimen, there is a series of lines that differ in phase from the original. Analogous X-ray diffraction patterns were also obtained for specimens of BaF_2 given the same conditions. At pressures of 120 kbar, the initial temperature is -150°C; in both investigated fluorides, the lines of the new phase are

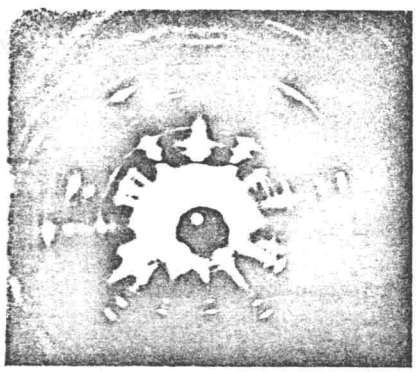

Fig. 3. Laue diffraction pattern of CaF_2 specimen after shock compression: P = 200 kbar, t = -150°C.

also recorded, although their number and intensity were considerably lower.

In all other cases (P>200 kbar, t = -150°C; all pressures at specimen temperatures of +20°, porous specimens of fluorides of Ca), practically no lines of the new phase were detected. This indicates that at an initial temperature of -150°C and pressure of 200 kbar, nearly optimal conditions are realized for preserving the metastable phase of fluorides of calcium and barium after removal of pressures. It is interesting to note that the number of lines of this phase and their intensity varied greatly in separate experiments carried out using a rigorously identical setup. Apparently the size of the crystallites of this phase is at the limit of sensitivity of X-ray structural analysis methods, $L \approx 10^{-4}$ cm. According to [15], the reflection of X-rays from the crystallite takes place when its dimensions exceed the wavelength of the radiation by a factor of 1000. To substantiate this hypothesis, some of the specimens (those which had exhibited the greatest contrast to one another) were subjected to analysis by a UEMB-100 electron microscope. The use of electron diffraction on a crystal lattice having a wavelength 10 times less than that of the characteristic radiation of copper made it possible in both cases to record on the electron-diffraction patterns new lines of identical number and intensity, in order to study the structure of specimens. These results enable us to evaluate the maximum dimensions of crystallites of the high pressure phase formed in shock waves: $L \sim 10^{-5} - 10^{-4}$ cm.

Our count of lines in the Debye powder diagrams and electron diffraction patterns containing lines of the new phase led us to identify it as an orthorhombic phase, isostructural to α-$PbCl_2$ (spatial group Pmnb, coordination number 9), with lattice parameters close to those