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Letters to the Editor

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Holographic determination of rocky sample deformation caused by the external forces

The applicability of holographic interferometry to determination of the surface deformations of rock samples has been investigated. The examination have been carried out by using both the double exposure and real time methods. The holographic interferograms obtained during wavefront reconstruction from double exposure holograms show the deformation of the examined surface. The experiment has been sponsored by the Academy of Mining and Metallurgy in Cracow.

In the experiment the methods of double exposure and real time holography have been used; the latter enabling a continuous observation of deformations suffered by the examined surfaces. In typical two-beam system has been used to the hologram recording in which the object wave — after having been scattered on the examined surface — met the reference beam in the plane of photographic plate. Unprocessed rocky sample has been subject to uniaxial external forces obtained with the help of a hydraulic press of continuously regulated pressure.

The holographic interferograms are presented in figs 1–8, have been obtained by wavefront reconstruction from the double

Fig. 1. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 0$ at, $p_2 = 5.0$ at

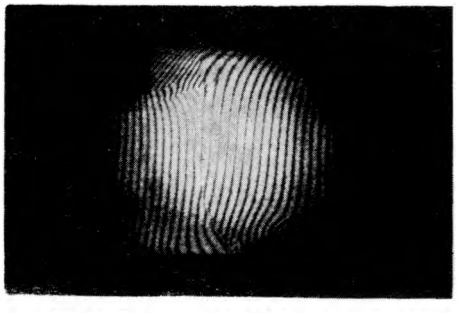

Fig. 2. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 5.0$ at, $p_2 = 10.0$ at

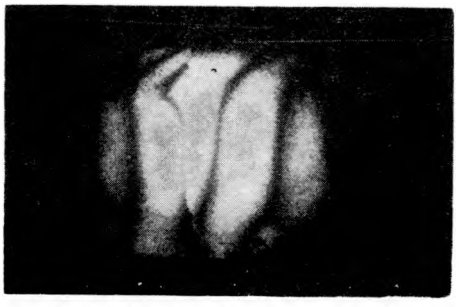

Fig. 3. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 9.5$ at, $p_2 = 10.5$ at

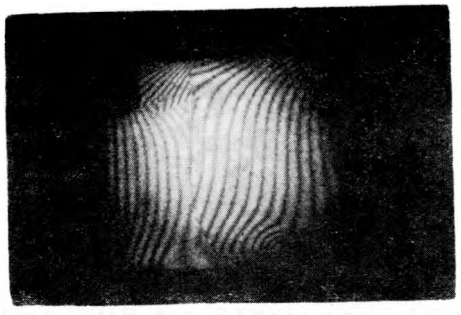

Fig. 4. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 10.0$ at, $p_2 = 20.0$ at

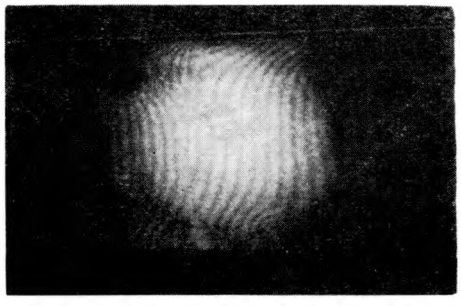

Fig. 5. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 15.0$ at, $p_2 = 20.0$ at

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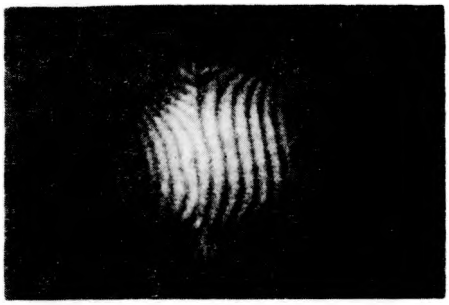

Fig. 6. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 20.0$ at, $p_2 = 25.0$ at

Fig. 7. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 25.0$ at, $p_2 = 30.0$ at

Fig. 8. Holographic interferograms obtained during wavefront reconstruction from the double-exposure holograms: $p_1 = 30.0$ at, $p_2 = 35.0$ at

hologram recorded during one of the series of surface deformation measurements.

The interferograms shown illustrate the deformation of the rock sample surface at different pressures hydraulic press applied to the sample. The values of pressure applied during the first (p_1) and second (p_2) exposures (during recording of the double-exposure hologram) are given under each interferogram. The vertical line visible on interferograms shows the crack of the sample surface which occurred in an earlier experiment. On the basis of the presented interferograms it may be stated that different fringe densities appeared in the interferograms at the presence of different pressures. The fact that different densities of interference fringes on holographic interferograms correspond to a constant increase of pressure (by $p = 5$ at) prove that the strains are increasing nonlinearly.

The steady observation of deformation were carried out with the help of the real time method by changing the pressure in a continuous way. In this case the experiment was carried out in such a way that the examined sample surface has been recorded on a hologram first in the absence of the inducing forces, and then after applying the external pressure. The interference image appearing due to superposition of light waves corresponding to the non-deformed and deformed surfaces was observed, as it is used for the real time methods. Observation through the hologram of point selected on the examined surface allows to count the number of fringes which passed this point — when changing the pressure — to determine the direction of the shift. In fig. 9 the change in pressure denoted on the x-axis was in this

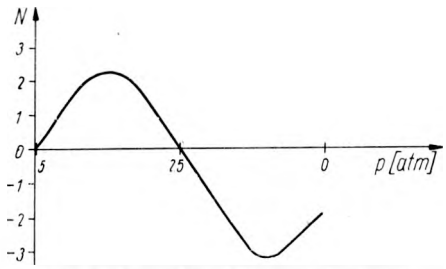

Fig. 9. Dependence of the number of fringes on the direction of their shift through the point observed on the deformed surface while changing the pressure from 5 at to zero

case lowered from 5 at to zero. On the y-axis the number of interference fringes are represented which passed the observed point on the examined surface. In this figure the change of the fringe shift is denoted by the change of the curve direction which illustrates the situation discussed.

The experiment carried out showed the applicability of the method to the examination of natural deformations of unprocessed rock surfaces while the estimation of deformations may be made with the help of the method published in [1]. The results obtained in the course of this experiment allow to expect, that after some adaptations of the used setup and the measuring system the examination of strains in an orogen will be also possible.

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Голографические методы исследования деформации проб породы под влиянием внешних сил

Проверена пригодность голографической интерферометрии для исследования деформации поверхности проб пород. В исследовании применялись метод двойной голографии и метод реального времени (real time). Представлены голографические интерферограммы, полученные при восстановлении фронта волны по двойным голограммам, изображающие деформацию поверхности исследуемой пробы.

Reference

[1] Aleksandrov E. B., Bonch-Bruievitch A. M., J. Techn. Phys., **37**, 2 (1967).

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