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INTRACRYSTALLINE STRAIN AND TEXTURE MEASUREMENTS ON GEOLOGICAL MATERIALS BY NEUTRON DIFFRACTION (poster)

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Studies of strain-stress-texture relations in geological materials concern a rapidly developing new field of interests in geoscience, which nevertheless is extremely complicated, because little is known on the mutual relations between factors as stress, structure, texture, stress redistribution, residual stress, composition etc. Because of the high penetration depth of neutrons and because several lattice planes may be detected simultaneously in combination with a high spectral resolution, the method of neutron time-of-flight diffraction is to prefer for studies on geological samples.

Selected results are reported, derived from in situ experiments with sandstone and dolomite under load, also related to different scales of time. The experiments were carried out at the Joint Institute for Nuclear Research in Dubna (Russia) at the diffractometer EPSPILON-MDS and at the diffractometer ENGIN at the Rutherford Appleton Laboratory in Chilton, Oxfordshire (UK). Texture related differences of residual strain distributions are discussed relating the dunite and quartzite part of a superimposed (shock)-deformed composite. Using the RETIEF-method, possible changes (stretching or compressing) of the unit cell (forsterite, quartz) were calculated from the observed peak positions in a direct manner. Towards the interface strongly decreasing tensile and orientation-dependent but uniform residual strain evolution in the quartzite is in contrast to weakly increasing and less orientation-dependent, inconsistent tensile residual strain, approaching the interface from the dunite part. Residual strain levels strongly depend on textural features. Maximum residual tensile strain values were determined for quartz [0001]-orientations, reflecting the non-coaxial, but subdivided component of the quartz texture, or – relating the quartzite macrostructure – quartz [0001]-orientations perpendicular to the foliation plane.

EARTHQUAKE SEQUENCES AT A FAULT BEND – RESULTS OF NUMERICAL MODELLING (poster)

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Numerical simulations using the three-dimensional distinct element code 3DEC were performed for a better understanding of repeating earthquake rupture processes on a segmented fault. Tectonic loading, stress accumulation, subsequent failure, and the recurrence of the process were investigated on these loaded segments located at different parts of a non-planar strike-slip fault. For the model used the loading boundary conditions and the non-planar geometry were arranged in such a way that the rupture segments are either transpressional or transtensional.

For the loaded fault segments, a Mohr-Coulomb slip model with stick-slip behaviour was used. Repeated failure processes were allowed, because an instantaneous healing process according to Heaton (1990) was introduced. The loaded segments themselves were embedded in a sliding fault surrounding.

Different parameter sets were applied to produce synthetic earthquake sequences. Especially the influence of the Mohr-Coulomb failure criteria on the rupture process was investigated and simulations with different slip models were examined. Generally, the generated sequences possess the main characteristic features of real earthquake catalogues, such as (I) magnitude-frequency distributions according to the Gutenberg-Richter law, (II) significantly varying temporal occurrence of main events, (III) foreshock-aftershock distributions and (IV) a time period of seismic quiescence before main shocks. The spatio-temporal event distribution indicates a seismic quiescence only on the segment with the main event. At the same time, the adjacent segment is characterized by an increasing failure activity. Finally, the foreshock activity shows an increase as well as the aftershock activity a decrease in accordance with the Omori law.


THE ARISING OF SEISMIC FLOW PERIODIC OSCILLATIONS BEFORE STRONG EARTHQUAKES

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A great role in the SOC model is attached to the correlation of widely spaced seismic events (collective behavior) with the development of the strong earthquake. Supposedly, such phenomenon can give rise to periodic variations. In view of relatively poor seismological statistics and small duration of observation series of uniform catalogues, it is reasonable to use the method of searching for hidden periodicity that maximally use initial information. In this research, the method was used of detecting periodic components in a “point” process, an example of which is a time sequence of seismic event appearance. The model of function including Poisson process and periodic oscillations was calculated with the use of maximum likelihood method. The effect was revealed of the appearance of periodic oscillations of seismic flow before some of the earthquakes of Kamchatka with magnitude more than 7. The oscillations appeared in the areas with linear dimensions of the order of 100 km including the centers of those earthquakes. Maximal oscillation periods range from 0.8 to 1.8 years. As the moment of strong earthquake approaches, a regular shift of spectra maximums towards lower periods was revealed. The analysis of the microseism record of Petropavlovsk Kamchatsky station and laboratory experiment detected periodic oscillations in the minute period’s range. In the first approximation, the physical reason of the appearance and evolution of oscillations is associated with the group behavior of weak seismic events with the development of instability in the focal area of main event. This phenomenon broadens the list of earthquake precursors. The work was supported by grant Nsh-1270.2003.5.

AN INVESTIGATION OF THERMAL AND DEFORMATION PROPERTIES OF QUARTZITE AT THE TEMPERATURE INTERVAL OF POLYMORPHIC a-b TRANSITION BY MEANS OF NEUTRON DIFFRACTION AND ACOUSTIC EMISSION

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The process of preparation and development of an earthquake source cannot be completely understood and described without creating more accurate and complicated physical models of the geological medium. The phenomena of instability of the rocks under influence of high temperatures and pressure are especially badly investigated, including during phase (polymorphic transition). So, studying of abnormal physical properties of the rockforming minerals at high temperatures and pressure, for example, of the nature of abnormal behaviour of polycrystalline quartz at the temperature interval of a-b transition (560 - 600 °C) is actual. The behavior of natural polycrystalline quartz (Shokshinsky quartzite) was investigated by means of time-of-flight neutron diffraction and acoustic emission at the SKAT-TKOS measuring complex installed at the beamline 7a of fast pulsed reactor IBR-2. Also, the neutron diffraction measurements were performed with the quartz powder sample at the HRFD diffractometer. The changes of the lattice spacing of quartz during the a-b transition were measured and values of lattice stresses were estimated. It is shown that the transition occurred at the temperature interval 540 to 573 °C and the sample was completely consisted of b-quartz at a temperature...