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The wave-like geodynamic reorganizations revealed by the change in orientation of the paleostress axes

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Sedimentary rock fracturing is a reliable stress indicator when properly measured, processed and interpreted. Our long-term field observations and theoretical considerations show that the primary joint sets are formed at the stage of diagenesis of sediments at horizontal bedding. Most likely, it happens due to internal instability of sediments manifested in localised form, which leads to formation of two conjugate systems of shear discontinuities. This model allows us to reconstruct the orientation of the axis of the maximum horizontal paleo-compression $S_{H,max}$ and to determine the period of its existence up to the scale of geological time. During more than 30 years of our field observations, we collected about 400,000 individual joint measurements in many regions of Eurasia. These data were applied to paleostress reconstruction by using interpretation of primary jointing formation mentioned above. Both spatial distributions of paleostress axes and the evolution of these distributions in time determined by our techniques are in reasonably good agreement with paleogeodynamic reconstructions obtained by other approaches. A distinctive feature of the paleostress evolution is that at certain times orientation of the $S_{H,max}$ axes changes abruptly, turning at an angle up to 90°. Sometimes these changes are gradually spreading to neighboring regions. We attribute this phenomenon to the geodynamic reorganization which spreads over the space at a certain speed. Such wave-like spreading was observed in the East-European platform, the Tien-Shan, along the arc Pamirs-Tibet-Vietnam and in other regions.

From the perspective of this phenomenon, the Caucasus-Zagros region is of particular interest. Here from the end of the Early Cretaceous to the present time the $S_{H,max}$ axis with small spatial variations was NE oriented. However, we identified a relatively short period in the Miocene characterized by geodynamic reorganization. In the early middle Miocene in the south-east of the region (the south-eastern part of the Zagros) the $S_{H,max}$ axis changed orientation from NE to NW. At this time in the north of the region (Central Pre-Caucasus) the $S_{H,max}$ axis was still directed towards NE. But in the middle Sarmatian, when the southern part of the region already had NE orientation of compression, in the northern part the $S_{H,max}$ axis reoriented in NNW direction. As in the south of the region, this reorientation was short and in late Sarmatian the $S_{H,max}$ axis regained his usual NE orientation. The identified short-term restructuring that began in the south-east of the region in the early middle Miocene and which reached the northern part of the region in the early Late Miocene can be interpreted as the process of the south to north moving of the solitary wave of geodynamic perturbation. The velocity of the wave is estimated as 0.1-1.0 m/year.