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Book review

A REVIEW OF S. I. SHERMAN'S MONOGRAPH "SEISMIC PROCESS AND THE FORECAST OF EARTHQUAKES: TECTONOPHYSICAL CONCEPTION"

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О ФУНДАМЕНТАЛЬНОЙ МОНОГРАФИИ С.И. ШЕРМАНА «СЕЙСМИЧЕСКИЙ ПРОЦЕСС И ПРОГНОЗ ЗЕМЛЕТРЯСЕНИЙ: ТЕКТОНОФИЗИЧЕСКАЯ КОНЦЕПЦИЯ»

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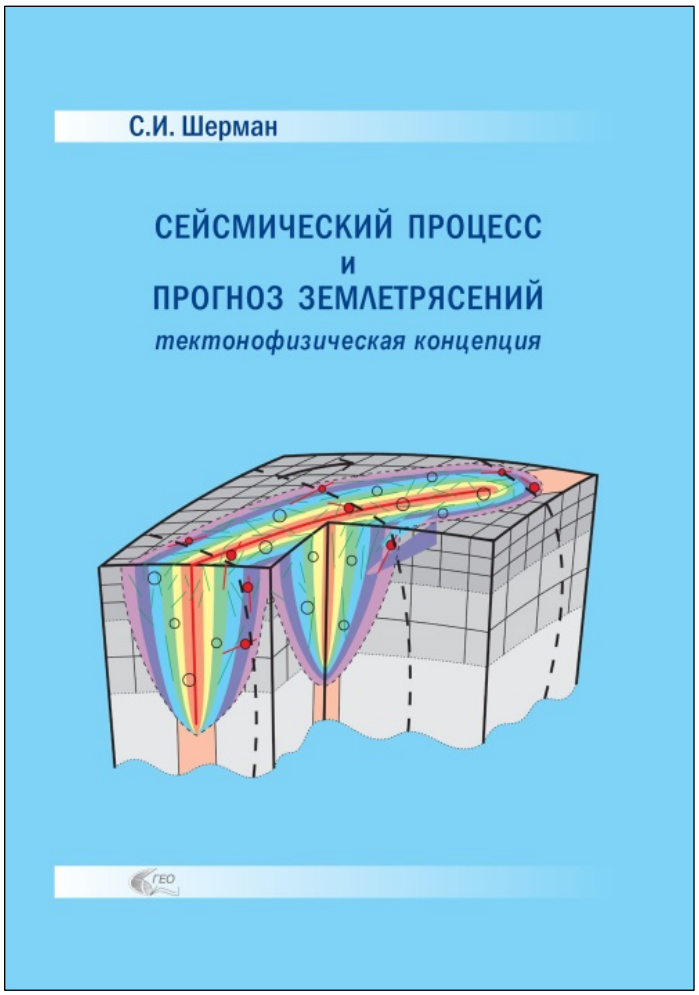
In 2014, S.I. Sherman published a monograph in GEO Academy Publishing House in Novosibirsk, Russia [*Sherman, 2014*], which consolidated results collected through more than 50 years of researches conducted by the author and his colleagues in the Baikal rift zone.

At the Institute of the Earth's Crust, Siberian Branch of RAS, the team of geologists had successfully conducted a number of research projects under the leadership by S.I. Sherman and pioneered in providing a comprehensive and detailed view of tectonophysical aspects of faulting under various lithospheric load conditions [*Sherman et al., 1991, 1992, 1994*]. Their conclusions were based on studies of faulting of the lithosphere and seismicity in the complex natural geological environment. In the above-mentioned books, S.I. Sherman authored the chapters on relationships between faulting and seismicity. He described parameters of faulting and their correlation with thicknesses of deformed layers, types and rates of loading and thus provided a complete tectonophysical description of faulting at various load types. This approach was bound to lead to the analysis of seismic activity as a process associated with faulting. There was thus a good reason why the reviewed monograph was developed and published.

The outstanding significance of S.I. Sherman's monograph and its fundamental character is well described in the introduction by the editor, G.A. Sobolev.



Sherman S.I., 2014. Seismic Process and the Forecast of Earthquakes: Tectonophysical Conception. Academic Publishing House "Geo", Novosibirsk, 359 p. ISBN 978-5-906284-50-1.

Шерман С.И. Сейсмический процесс и прогноз землетрясений: тектонофизическая концепция. Новосибирск: Академическое издательство «Гео», 2014. 359 с. ISBN 978-5-906284-50-1.

There is practically nothing to be added to what he said, save the fact that the book contains excellent reviews of seismic belts of the Earth, deformation waves and their generation under plastic flow conditions, phenomenological models of the seismic process and rheological parameters of the matter.

Not only does a good book offer a solution to the fundamental problem, but it helps determine principally new areas of further studies, as well as identify 'weak points' in the well-established concepts and theses. A few of the most significant points that came to this reviewer's mind after reading S.I. Sherman's book, are outlined below.

Independence from physical representations. An important aspect of the study is the concept of 'areas of dynamic influence of faults', which was introduced earlier in [*Sherman et al., 1983*], its formalization and the conclusion that "a seismic zone is an integrated independent geodynamic structure" (p. 113). A significant point of the author's theory is a thesis about independence of deformations and displacements occurring during seismic events from "the adopted concept of physics of earthquake foci or details of the release mechanism" (p. 186). The author thus emphasizes that the concept he is developing on the basis of geological data does not depend on our understanding of the *physics* of earthquake foci. In other words, as G.A. Sobolev put it, the author "laid the geological basis for the general principles of physics of earthquakes" (p. 6). Therefore, the seismic zone concept developed by the author can be considered quite universal.

Reviewing the data on plastic flow trends in deformed bodies which were published by L.B. Zuev and colleagues [*Zuev*, *2011*; *Zuev et al., 2008*] (p. 194–207), the author formulates a dimensionless invariant (6.3) on the relationship between plastic and elastic flow (p. 203), and using the schematics (Fig. 6.14, p. 204), he actually interprets the effect of such invariant. In the opinion of this reviewer, the data in fact gives grounds to conclude that a deformed body, having a plastic flow ability, can split into blocks as a result of plastic and elastic processes, i.e. it 'reorganizes itself', and sizes of such blocks are determined by invariant (6.3), which is clearly illustrated by Fig. 6.14. The 'self-splitting' process may probably occur given a fairly slow loading of the body as elastic and plastic processes in the body have enough time to become 'self-conformant'.

It appears that such interpretation of invariant (6.3) may constitute a totally new trend in tectonophysical research of faulting in the lithosphere and may help to solve the problem of boundaries between blocks. It was the subject of a sharp discussion that occurred after one of the reports during the conference "Faulting in the lithosphere and associated processes: a tectonophysical analysis" at the Institute of the Earth's Crust of SB RAS, Irkutsk [*Tveritinova, Vikulin, 2014*].

On rheid properties of the geological medium. Under the known geological concepts providing an understanding of solid bodies flow, the rheid mechanism of movements of the geological medium is distinguished. The notion of rheid deformation of rocks, i.e. flow deformation of rocks in solid state, was introduced in [*Carey*, *1953; King*, *1967*]. According to [*Leonov, 2008*] (p. 16, p. 255), "The concept of 'rheid deformation of rocks' embraces all kinds of tectonic flow (viscous, plastic, brittle-plastic, cataclastic, etc., and their various combinations), and this … allows avoiding inconsistencies and providing more adequate descriptions of natural processes which do not contradict the principles of mechanics and rheology". S.I. Sherman continues to use the term 'rheology' and 'rheological properties of the medium' rather than refer to or use the definitions

proposed by the geologists. He employs new concepts developed by V.E. Panin and his followers allowing the analysis of flow and the wavelike energy transfer in mesomediums, as well as the newest follow-up of these concepts by L.B. Zuev giving the grounds for applying the same solid state flow process to rock samples, i.e. a transit stage from the meso-level medium to the mega-level medium.

It is worth noting that the essentially pure geological definition of rheid property of the geomedium does not contain any reference to other properties or parameters of the geomedium, such as its fault- or faultless structure, temperature, etc. It needs mentioning that all the key rheological properties of substance were known already in the process of identifying and researching the rheid flow of the geomedium. Geologists, however, believed it necessary to introduce their own term, which "allows avoiding inconsistencies and providing more adequate descriptions of natural processes". There is no reason for revisiting it or excluding it from consideration as 'movements of the geomedium' [*Leonov, 2008*]. Thus, rather than appeal to rheological properties of bodies in accordance with concepts of the continuum mechanics, it appears more logical and appropriate to refer to 'movements of the geomedium' for interpreting geological processes under concepts of tectonophysics.

It should be noted that according to [*Vikulin, 2013*], through studies of faulting in the lithosphere from the point of view of rheid movements of the geomedium, it is possible to further develop the author's universal thesis so that it can incorporate, in a logical and geologically justified way, non-linear properties of the geomedium and its ability to move, which is followed by formation of geological vortex structures [*Vikulin, 2004; Milanovsky, 2007; Lee, 1929*] (such properties have not been taken into account in S.I. Sherman's thesis yet).

Wave movement in geology. In the strict physical and mathematical sense, a wave is a solution of an equation. The author reviews wave movements with reference to coordinates of new earthquake foci that successively occur in the zones of dynamic impact of faults. Deformation [*Kuzmin, 2004; Kuz'min, 2012*] and/or slow tectonic waves are likely to be solitary waves. Principles of their interaction differ from principles of interaction of 'conventional' sinusoid waves.

From the standpoint of physics, earthquake foci migration waves correspond to the definition of a wave. On a plain (axes: earthquake foci time / coordinates of earthquake foci positions along the fault), such waves are represented by successive groups of points located along relevant sections of straight lines. In this sense, the deformation process can more or less accurately be viewed as a wave phenomenon, when we mean earthquake foci migration waves. Actually, earthquake foci migration waves are referred to by the author for forecasting purposes in Chapter 9.

A significant conclusion of S.I. Sherman's study is that "deformation waves should be introduced in the notion of 'geomedium' and viewed as a dynamic parameter of the geomedium" (p. 283). If earthquake foci migration waves are understood as deformation waves, a new geodynamic parameter is introduced in [*Vikulin et al., 2012a, 2012b*] for the seismic process to be described with reference to such migration waves; it characterises the state of stresses of the geomedium in a seismic zone; and a physical analogue of such geodynamic parameter is also established.

Moreover, migration is not only typical of earthquake foci, but of volcanic eruption as well. The introduced geodynamic parameter [*Vikulin et al., 2012a, 2012b*] determines the state of stresses of the geomedium which is characterized by migration of geodynamic (seismic + volcanic + tectonic) activity [*Vikulin et al., 2012a, 2012b*].

As we see, the analysis of the wave process in S.I. Sherman's study is based, among other data, on a vast experience of geological studies and tectonophysical reconstructions employing the data from a volcanically inactive region, and, though they are not used for argumentation, undoubtedly, there is every reason to introduce the wave geodynamic parameter "in the scope of the geomedium concept". Further studies may focus on a specific type of such parameter.

Notwithstanding a few critical comments made here, the reviewed monograph by S.I. Sherman is a fundamental work that presents a significant step forward in studies of faulting in the lithosphere and its relationships with seismicity.

Surely S.I. Sherman's book "Seismic Process and the Forecast of Earthquakes: Tectonophysical Conception" is of great interest and will be an asset to a broad range of researches in Earth sciences.

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