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TASKS OF THE USSR SEISMIC SERVICE

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The Academy of Sciences has been and is the USSR's main institution of seismology; the seismic service and seismological research are concentrated in it. Recently, however, similar [illegible] have been started in the various republics, mainly in those frequently subjected to severe earthquakes. It is extremely important, therefore, to define the immediate tasks of the Soviet seismic service in order to coordinate the seismological works, now being conducted in various parts of the country, for the sake of a common goal; that is, detailed and accurate division of seismic regions in order to develop methods of constructing earthquake-proof structures and of forecasting earthquakes. Detailed and accurate seismic regional division, combined with earthquake-proof construction based upon strict scientific data and timely and correct forecasting of earthquakes, may save much material goods from destruction and, what is more important, prevent the catastrophes among the population that result from earthquakes.

The decrees of the USSR Council of Ministers on the construction of new hydroelectric stations and canals impose a number of tasks upon Soviet seismologists. For example, the Presidium of the Academy of Sciences USSR in its decree of 13 September 1950 concerning aid in the construction of the Main Turkmen Canal provided for the compilation of a more accurate map on the seismicity of Western Turkmenia and the development of a suitable scale of earthquake intensity "in order to take the seismic activity of the western part of the Turkmen SSR into account in the planning of hydrotechnical, industrial, and communal buildings".

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Before discussing the immediate tasks of seismology and the USSR seismic service, we should like briefly to characterize their present status.

One of the early accomplishments in seismology and the seismic service was the discovery of a relationship among zones of high tectonic activity, orogenic zones, and earthquake epicenters. Intensive deformation of the earth's crust, upthrusts and subsidences, occur in these zones; the speed of this deformation is measured in millimeters per year or, rarely, in centimeters per year. Deformation of the earth's crust is uniform in both time and space. Regions of upthrust alternate with regions of subsidence. This process leads to elastic and plastic deformations, to the building up of elastic stresses, and finally -- because of the insufficient plasticity with respect to the build-up of stresses -- to upheavals, fractures, and also dislocations and faults, which frequently take place along surfaces of separation already present in the earth's crust.

The definite presence of crust deformation due to internal forces has been confirmed by field geological studies and its determination is a sine qua non in seismic and geophysical studies.

The distribution of earthquake centra versus depth began to be compared with the crust's structural characteristics observed on the surface upon discovery of methods for determining the depth of an earthquake centrum. These comparisons resulted in the establishment of a relationship between geomorphology, deep structural characteristics, and earthquake centra.

One can observe quite clear relationships between visible topography and tectonic movements in deep-water basins, where the relief has been changed very little by subsequent accumulation of sedimentary rocks. There have been observed in such places oppositely-directed movements of the crust at the continental sections and under the sea bottom; moreover, it has been established that earthquake centra are apparently connected with the boundary where the direction of motion changes (upthrusts are replaced by subsidence). As a result of these deformations, considerable stresses are built up which lead to dislocation or rupture in some parts of the crust. The Crimea is a good example of this type of process. Figure 1 shows the position of earthquake centra; this diagram indicates that there are surfaces along which the Crimean peninsula probably overthrust on the subsiding bottom of the Black Sea (see also Figure 2).

This type of process also stands out quite clearly for large structures. Figure 3 shows the position of earthquake centra in the Okhotsk Sea region, testifying to the presence of a deep tilted structural surface which intersects the earth's surface in the deep-water recession. Seismic observations show that overthrust of the continent and subsidence of the bottom of the Pacific Ocean is generally observed in this case. The same holds true on the opposite shore of the Pacific Ocean; that is, in America and in some other places in the ocean (particularly in the region of the Friendly Islands).

The most active seismic zones in the USSR are concentrated in the land mass. These structures are more complex from the standpoint of detecting differential movements, and tectonic movements in them are not always sufficiently clear. In addition, such continental structures are sometimes complicated by thick strata of loose sedimentary rocks, particularly in Middle Asia as concerns the USSR. Even in these regions, however, the relationship between tectonic characteristics and the position of earthquake centra can usually be established beyond doubt, as recent works by Soviet geophysicists show. For example, I. Ye. Gubin demonstrated very clearly the relationship between the position of zones of fracture of the earth's crust and overthrusts, on the one hand, and places where the heaviest earthquakes had occured in Tadzhik SSR, on the other.

The existing seismic regional division of the USSR was drawn up from data based upon the qualitative scale of earthquake intensity, and also from descriptive statistical material on earthquakes which had occurred in a certain region, with consideration for the geological structure of the region. But in this division there was not, nor could there be under the former status of the seismic service, a complete relationship between the seismic zones and the tectonic characteristics of the crust structure. The regional seismic stations which were organized in the 1920's and 1930's for seismic regional division of the USSR could characterize the seismic regions only roughly because of their small number.

As for earthquake-proof construction, for which the seismic service must provide basic data on types of ground movements in strong earthquakes, it has been conducted until now on the basis of visual data on the destructive consequences of earthquakes. However, this data is not sufficient qualitatively to characterize ground vibration in an earthquake. Destruction in earthquakes is determined not only by amplitude but also by period of vibration, and this can be established only by accurate records of heavy earthquakes.

Soviet seismologists are now confronted with the problem of developing methods for forecasting earthquakes. These methods can hardly have universal application. Most probably, they must be related to definite structural characteristics of the crust and characteristics of the earthquake process in a given locality. In connection with this, the possibility of using different signs preceding earthquakes in certain regions cannot be excluded. The failures of past forecasts is explained not only by the absence of serious work in this field but also by the fact that the effects preceding earthquakes were not compared with the tangible tectonic characteristics of the crust structure and with processes connected with the emergence of earthquakes. For example, where there were several blocks of the earth's crust isolated by surfaces of separation and undergoing deformation in different directions, the signs preceding earthquakes were not related to the actual structure and thus were often misinterpreted. Therefore, it is important to know the tectonic and seismic characteristics of each surface of separation in the earth's crust, of each mountain range situated in a seismically-active region.

In the development of methods for forecasting earthquakes, we must take into consideration the slowly progressing deformation process, which, while not uniform, usually proceeds in one direction in a given geological time. Clarification of this process will permit us to establish the degree of preparation for an earthquake or seismic danger of a certain tectonic structure.

One of the proposed reasons for earthquakes, especially for deep earthquakes (for centra down to 700 km), are phase conversions of matter from one state to another, which may take place under changes of pressure and temperature in the earth's depths. There are forces which provoke earthquakes. Sometimes these may be insignificant forces in themselves, a "hammer blow" -- for example, changes in barometric pressure, sediment accumulation, etc -- and also variations in the earthquake-generating forces themselves. For timely dection of all these phenomena by physical and geophysical methods, once again it is necessary to know the behavior and seismic characteristic of each active tectonic structure.

Thus the seismic service of the USSR must make available the seismic characteristics of each active tectonic structure, each fracture of the earth's crust, in order to solve the problems facing it. While previously we could determine the position of an earthquake centrum with a maximum accuracy of 10-20 km, this figure should now be reduced to 2-5 km. The number of seismic stations must be increased considerably. These stations should be situated mainly in seismically-active regions and equipped both with low-sensitive equipment for recording ground vibrations in destructive and heavy earthquakes (necessary for purposes of earthquake-proof construction) and highly-sensitive equipment for detailed study of the seismic characteristics of each active structure. A considerable number of seismic stations situated near epicentral zones would permit more accurate determinations of the position of epicenters, depth of centra, and - what is especially important - the configuration of the centra and the type of forces acting in the centrum at the time of the eartnquake. After methods of forecasting earthquakes are devised, special continuous observations at stations will be the basis for timely forecasting of earthquakes.

We should keep in mind that no matter how successfully the locations for new seismic stations are chosen, the need for relocating them may arise during their work. In addition, the seismic observations must be conducted in unpopulated areas. All this requires the development of automatic seismic stations for prolonged operation (similar meteorological stations have been developed and are now in operation). Such stations would cut down expenses for construction of the station buildings and would require fewer personnel.

The time service must be improved considerably in the near future in order to increase the accuracy of the observational results of seismic stations. The error in determining the time of arrival of seismic waves must be reduced to 0.1-0.2 seconds, which will make it possible to determine the position of the centra with an accuracy of 1-2 km. For this purpose, the seismic stations must be equipped with automatic devices for checking the time along with good contact clocks. In addition to the travel time of seismic waves the observations of modern seismic stations should make it possible to determine the type of ground vibrations during earthquakes and the direction of the waves arriving at the station. Methods of processing observations based on the dynamic theory of elasticity must be devised in order to use this data to study the earthquake process, direction of forces acting in the centrum, and structure of the earth's crust. This trend has started to develop at the present time and promises many interesting results.

As it continues to grow, the seismic service must become more and more operational; this will require not only a general intensification of work in seismology, but also the creation of regional seismic services in the republics. Centers of seismic studies in the republics should be geophysical institutes or sectors in republic academies of sciences or in affiliates of the Academy of Sciences USSR, and also central republic seismic stations, which will process and generalize the observations of stations under their jurisdiction and make studies on the seismic conditions of active tectonic structures, on detailed seismic regional division, on forecasting earthquakes, and on the structure of the earth's crust.

These are the immediate problems of the Soviet seismic service, arising from the needs of the economy. By solving these problems, the seismic service of the USSR will render substantial assistance in the economic utilization and further development of the economy of many regions.

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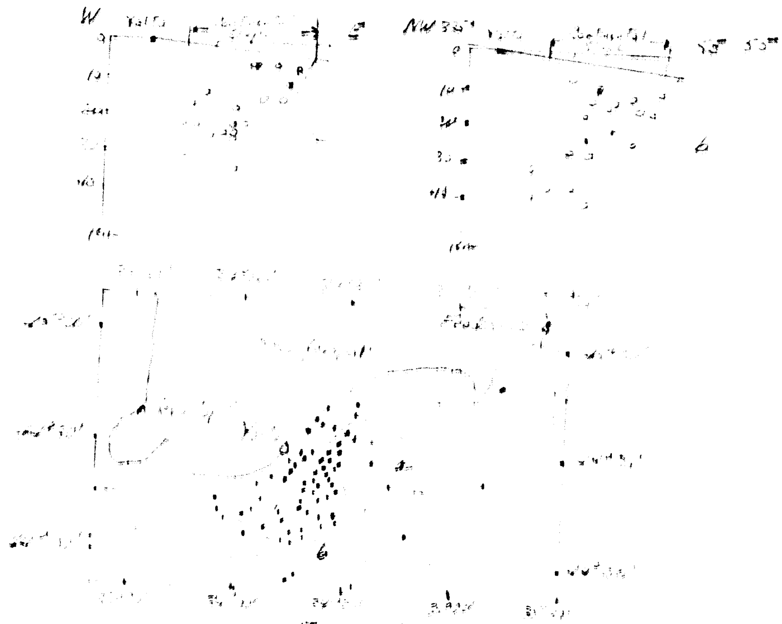

Figure 1

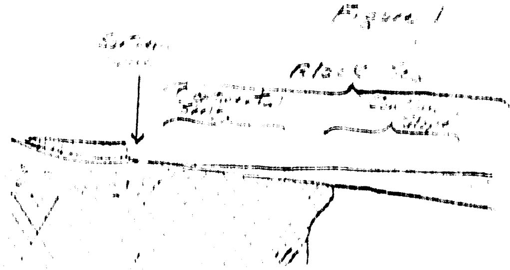

Figure 2

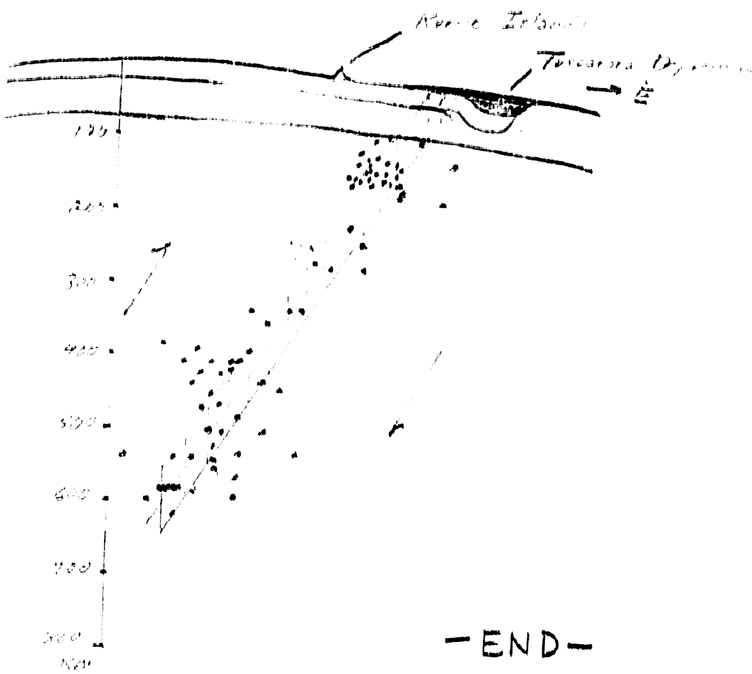

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Figure 3

Table [illegible]. Measurements of Radio[illegible] in Various Parts of the Graft and Wilding

Components of the hybrid plant	Counts per minute				
	[illegible] June		2[illegible] June		
	Young Leaves	Old Leaves	Young Leaves	Old Leaves	Root
Graft – Mikado	[illegible]75	[illegible]	-	-	
Wilding – Golden Queen	none	none	8[illegible]	53	39

Table 2. Measurements of Rad. activity in Various Parts of the Graft and Wilding.

Components of the hybrid plant	Counts per minute				
	[illegible] July			19 July	
	Young leaves	Old leaves	Fruit	Young leaves	Old leaves
Graft – Yellow Cherry	164[illegible]	276	277	–	–
Wilding – Potato-leaved	–	–	–	37	none

Table 3. Measurements of Radioactivity in Various Parts of the Graft and Wilding.

Components of the hybrid plant.	Designations of leaves and shoots*	Counts per minute					
		19 July	21 July	26 July	6 August	15 August	18 August
Graft - Yellow Cherry	1	490	1190	1263	-	-	-
	2	376	258	320	-	-	-
	3	82	102	139	-	-	-
	4	9	21	68	-	-	-
	6	39	-	-	-	-	-
	8	21	-	-	-	-	-
	8 a	62	93	133	-	-	-
	11	-	-	-	-	-	-
	11 a	-	140	148	-	-	-
	12	-	-	-	-	-	-
	13	-	-	-	-	-	-
	16	-	-	-	173	158	108
	17	-	39	-	67	104	43
Wilding - Mikado	A	-	25	-	-	36	-
	F	-	-	-	-	25	-
		-	-	-	-		

* a are young shoots of the graft, while A, B, and C are tips of shoots of the wilding