

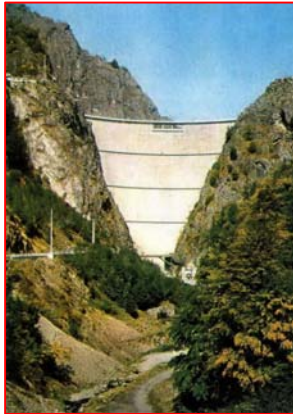
ASPECTS CONCERNING SEISMICITY ANALYSES OF THE VIDRARU-ARGES DAM AREA

by
Traian Moldoveanu¹, Klaus-Peter Bonjer², Mircea Pecingine³

¹ S.C. Geotec Consulting SRL, Bucharest, Romania
² formerly with the Geophysical Institute, KIT, Karlsruhe, Germany
³ S.C. Hidroelectrica SA, Filiala S.H. Curtea de Arges, Romania

The Vidraru-Arges dam is located in a seismically active region of the Romanian Carpathian Mountains. The initial filling of the reservoir started in 1965. The maximum height of the water level is 167 m and a maximum volume of 465x10⁶ m³ water can be stored. The reservoir is operated at water levels in the average between 150 and 100 m, but partly also down to 70 m. The seismic hazard of the reservoir site is determined by the strong intermediate-depth earthquakes of the Vrancea zone (epicenter distances are about 140-183 km) and by the local seismic activity of the nearby Fagaras and Campulung focal areas with epicenter distances of about 20-40 km. One of the strongest and well studied local earthquakes occurred on January 26, 1916 near the village of Cumpana, which is situated at the tail of the Vidraru reservoir at a distance of 15 km North of the dam. The source parameters are: To=07:37:55(UT), Ms=6.5, lo=VIII (MSK), focal depth h=20km.

The Vidraru-Arges Reservoir



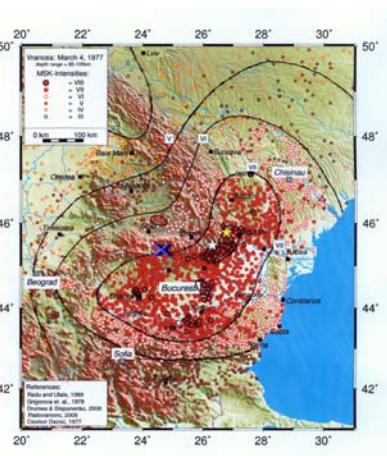
Construction height: 166m
Length at crest: 305m
Volume of concrete: 480.000m³
Storage volume: 465 • 10⁶m³

The analysis of local seismicity

The seismic surveillance of the Vidraru-Arges dam and reservoir started in April 1975 and is continuing until today. On the average, 74 earthquakes with magnitudes between 0.5 < M < 3.7 are observed per year. Focal depths are mostly concentrated around 10 km. The comparison of the temporal changes of the seismic activity and the variation of the water level reveals that the seismic activity increases shortly after the water level decreases to about 120 to 110 m and the seismic activity ceases when the reservoir level is approaching the maximum height of about 150m.

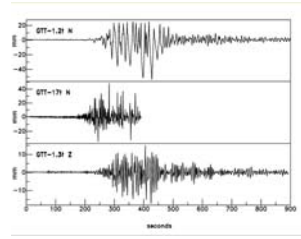
The Seismic Hazard of the Vidraru-Arges Dam

The intermediate-depth Vrancea Source

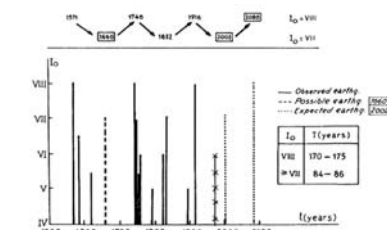


Vrancea March 4, 1977 (Mw=7.4): Intensity Pattern (the blue cross shows the location of the dam)

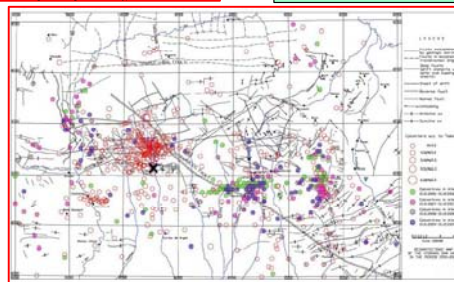
The local (crustal) Source Areas: Arges-Fagaras-Campulung



Strongest instrumentally recorded earthquake from the AFC-area: Fagaras January 26, 1916, Ms=6.5 (Molodtsov et al., 1977)



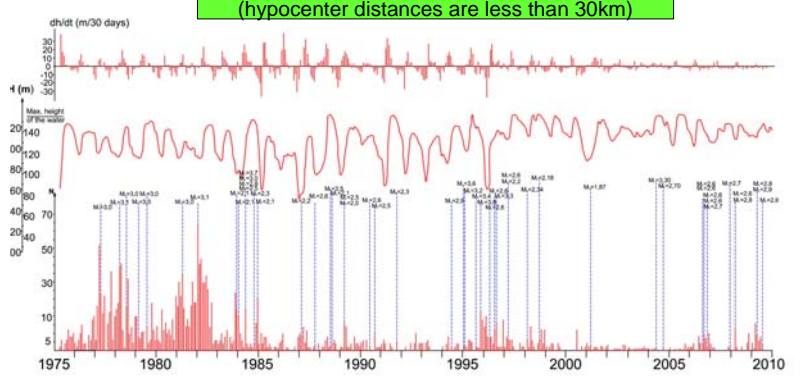
Seismic history of the AFC-area (Radu, 1990)



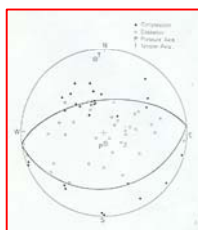
Epicenter map of the Arges-Fagaras-Campulung area. Seismic data are from Radu (1979) and Moldoveanu (1976-2010)

The Vidraru-Arges - Reservoir

Annual fluctuations of the water-level and the local seismic activity (hypocenter distances are less than 30km)

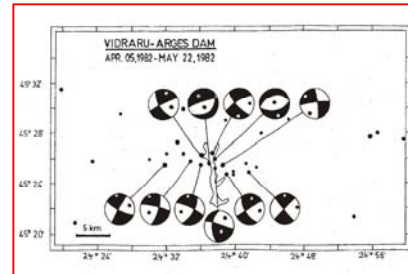


The repeatedly observed changes in the seismic activity could be understood on the one hand as a stabilization of the seismic regime by an increase of the load through filling the reservoir, and on the other hand by a destabilization, i.e. triggering the seismic activity by unloading the reservoir. This hypothesis would be supported, if the area is experiencing a thrust regime. However, there is neither geological nor seismological evidence for thrust faulting in the lake area. E.g. a composite fault-plane solution from 22 events of the time period from January to June 1977 shows nearly pure normal faulting (Nourescu et al., 1979). Furthermore, the April 12, 1969 Campulung Mw=5.2 earthquake (at a distance of about 40km from the reservoir) showed a strike-slip mechanism with a small normal faulting component (Radu, 1974). To increase the reliability of the determination of the focal parameters in the closer vicinity of the reservoir and to resolve the (apparent) discrepancy concerning the observation of normal faulting and a hypothetical thrust regime, a seismic survey with 10 mobile seismic stations was performed over a period of two months in April and May, 1982 (Moldoveanu et al., 1982). During this time about 30 locatable earthquakes were recorded. Eleven events were well enough recorded (concerning the number of records and azimuthal coverage) to allow the construction of fault plane solutions by the use of first motions. Most of the earthquakes occurred in the northern lake area. The epicenters show a pronounced E-W trend. The middle part of the reservoir and the dam area are free of events during this survey. Further evidence for such lack of activity beneath the lake is provided by the epicenter distribution of the monitoring time period 1976-1979 (Moldoveanu et al., 1982) when a significantly greater number of earthquakes could be located.

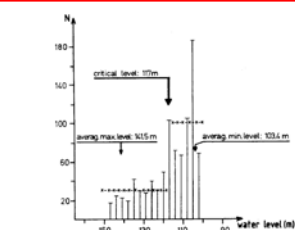


Composite solutions of the fault plane for 22 local earthquakes depending of the water level in the lake registered between 01.01.1977-14.06.1977

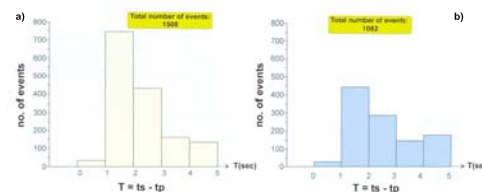
- I. The Vidraru-Arges Reservoir is located within an active seismic area.
- II. Earthquake activity changes with the fluctuation of the water level.
- III. Local earthquakes with magnitudes up to Ml=3.7 are recorded in the closer vicinity of the reservoir so far.
- IV. More precise discrimination between natural and induced earthquake activity requires long-term and high quality data acquisition.



The 1982 Arges campaign: epicenter and fault plane distribution



Average number of events as a function of water level (June 1975-June 1982)



Change of seismic activity during the emptying (a) and filling (b) cycles of the Vidraru-Arges reservoir (April 1975 - December 2009). Note that the majority of the events are at hypocenter distances of about 10 to 15 km.