4.7.3. FAULTING AND DIAGENETIC PROCESSES RELATED TO SEISMICITY WITH SOME IMPLICATIONS IN THE VRANCEA ACTIVE GEODYNAMIC ZONE

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Vrancea Geodynamic Active Zone (VGAZ) is located in southeastern part of Romania (Fig. 4.7.3.1.). It represents a narrow area (70-80km/20-30km) with NE-SW strike, cross-cut by numerous crustal/subcrustal faults, which covers the bend zone of East Carpathians (EC) Alpine Units and Focsani Depression (FD). This area is well known in Europe as being the most seismic area with high magnitude of earthquakes Mw >7.0. Generally, is an accepted fact that the seismicity from Vancea area is due to the detached oceanic slab from subducted plate.

Fig. 4.7.3.1. Tectonical map of surrounding area of Vrancea geodynamic active zone (according to Nikishin et al., 1996 from Ziegler et al., 2001)

Fluid pressure in active fault zones has been of considerable interest to seismologist and structural geologists specializing in mechanical involvement of crustal fluid in seismogenic faulting.

A typical fault zone consists of two major hydromechanical zones, breccia zone and fault mantle or damage zone. The main faults from a like graben structure of Vrancea Geodynamic Active Zone (Intramoesian, Peceneaga-Camena, Capidava-Ovidiu, Trotus, Pericarpatica, etc.) displays similar features. In this area along the normal fault there are some discontinuities associated with breccias. The breccia zone are likely to behave as ductile and to creep at low to moderate strain stress rates; it can fracture at the very high strain rates related with seismogenic faulting. Where the breccia is missing inside the fault plane, water can normally flow to deeper crustal levels. The fault core is a low permeability barrier which crosses groundwater flow.

In Vrancea continental-collision/subduction processes (aborted subduction) there is an interaction between fluids achieved by subducted slab and cover mantle. The fluid appears to be transported in mantle by slab as the consequence of dehydration mineral

reactions, with water releases. This water can dissolve some silica minerals from slab and the resulted fluid move upwards to the warmer cover mantle; therefore, T and P from above slab and water flux controls the production magma dehydration.

The interaction between slab and fluids is another subject of our discussion which is resumed to the followings: 1) the slab represents a warm oceanic crust with >10% H_2O % wt; 2) the dehydration reactions give a continue fluid production accompanied by the subduction process of the slab; 3) at 60-120km took place a massive lose of water from mantle; 4) the subduction of oceanic (basaltic-peridotitic) lithospheric crust is controlled by convective currents and due to different chemical composition this process is un-uniform, and 5) at 720 km basaltic crust pass to perovskitic lithology and at the bottom of low part of the mantle it can be partially melt if T>4000ºK.

The diagenetic processes related with time-evolution faults are strongly influenced by the intensity of the interstitial fluids circulation, permeability of the rock and mineral reactions. It is clear that along fault zones, in comparison with regional diagenetic alterations, the intensity of diagenesis processes increases. All these processes show a different behavior in direct relations with the type of rocks and fluids, T, P, magnitude of fractures and the mineral reactions.

In parallel with progressive increasing of burial depths the sediments become more and more compact. These process dependents of: 1) the sediment granules (dimensions, forms, mineralogical and chemical nature, impurities, etc.) and the interstitial fluids; 2) the properties of sediments (thickness, weight, porosity and permeability, internal structure, etc.) and 3) the dynamic factors (rate of basin sedimentation, P and T gradients, fluids, dynamic tectonic frame, etc.). The main effect of P and T action on compaction of the sediments is the expelling of water; this means the decrease of the total volume of the rocks and also, major structural and mineralogical modifications in these. Many of these solid-state transformations associated with neomorphism processes, like re-crystallization of some minerals (calcite, gypsum, anhydrite, chalcedony, etc.) polymorphic transformations (AlO.OH – Boehmit → Diaspor; SiO_2 - opal → chalcedony → quartz, etc.) can be placed in Vrancea seismogenic area in general, and crustal fault, in special. The other complex postdepositional alterations of sediments are related to diagenetic differentiations such as the diffusions, cementations and filled of the voids.

In comparison with this physical process, the chemical diagenesis (controlled by fluids) is a more complex process from the early to later stages. The diagenetic processes intensity increase with increasing of burial depths. Thus, at shallow burial depths (h≤2km and T≤70ºC, after Morad et al., 2000), the most important diagenetic alterations include precipitation of calcite, opal, microquartz, Fe-silicates (glauconite, betrhierite), sulfides and zeolites, and chloritization or illitization of clay minerals (Fig. 4.7.3.2.). At greater burial depth conditions, as h≥2km and T≤70-140ºC, these alterations consist of feldspar albitizations, illitization and chloritization of smectite and kaolinite, dickitization of kaolinite, carbonate and quartz cementation. These are the most important diagenetic processes because are induced by fluids in the fault zones.

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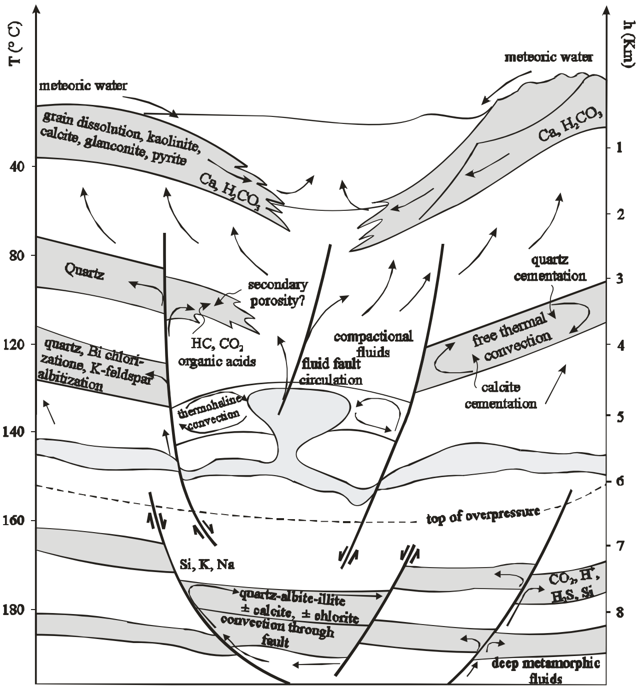

Fig. 4.7.3.2. Posibile spatial and temporal distribution of diagenetic alterations and patterns of fluid flow and mass transfer in Vrancea area (according to Morad et al., 2000; with completions)

In Vrancea area, as everywhere, repeated injections of hot water from deeper parts into a sedimentary columns has a result episodically emplacement of calcite cement. Also, it can carry dissolved gases and minerals, principally, upward and reprecipitates the calcite in more permeable zones in the rock. Degassing the CO_2 from rising pore waters likely triggered the precipitation and accounts for the relatively large volumes of cement.

The importance of fluids in dehydration and hydration reactions is underlined by: 1) fluid-dominated dehydration reactions with high fluid pressure and porosity and hydration reactions, which decreases the fluid pressure and porosity, and 2) solid-dehydration reactions with low fluid pressure and high porosity and fluid-dominated reactions with high fluid pressure and low porosity.

The seismic activity related with diagenetic processes in the upper part of the crust and metamorphic processes which occur in the lower parts of the crust have a cyclic behavior: any reaction triggered by an earthquake will likely reverse it before the next earthquake occurs – as the result of fluid pressure and environment mineral reactions. This model for explanation of the cycle's seismic activity can be partially applied to Vrancea seismogenic zone.

Although, the complex relationships between faulting-diagenesis-seismicity cannot give us reliable evidence for the existence of major discontinuities (petrological, compositional or seismic) within lithospheric mantle, this offers a working hypothesis to be further support for study the seismicity of VGAZ.

4.7.3.1. References

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