by the Hangenberg Event itself. On the contrary, younger «continental Hangenberg events», corresponding to the peak of the regression, have strongly affected the contemporaneous «upland» and «coastal» vegetations. These vegetations have not recovered after that peak, probably as a consequence of a colder climate. Latest Famennian climate was probably unstable with quick oscillating glacial and interglacial phases in the high latitudes.

Miospores dominating a specific continental environment during the late Famennian (after Streel & Scheckler 1990, Jarvis 1992, Dreesen *et al.*, 1993)

Well drained alluvial plains:
Aneurospora greggsii
(probably *Archaeopteris* microspores)

«Coal» swamps:
Diducites plicabilis-Auroraspora varia Complex
(Rhacophyton isospores)

Upstream swamp margins:
Grandispora gracilis
Apiculiretusispora coniferus

Downstream swamp margins:
Vallatisporites hystricosus
A uroraspora asperella
Retispora lepidophyta

COMPARISON OF INDUCTIVE AND NUMERICAL MODELS OF VARISCAN FLUID FLOW IN EASTERN BELGIUM

Philippe MUCHEZ[1] & Britta LÜNENSCHLOSS[2]

1. *Fysico-chemische Geologie, K.U.Leuven, Celestijnenlaan 200C, B-3001 Heverlee*
2. *Geoforschungszentrum Potsdam, Telegrafenberg A51, D-14473 Potsdam*

The ideas about fluid flow in compressional regimes remain controversial. Numerous papers highlight the importance of major fluid flow during folding and thrusting as others favour a closed system behaviour of the fluids. In a first instance a subdivision should be made between compression leading to orogenies and the compressional environment of accretionary prisms. Major fluid flow has been recorded along thrust, normal and strike-slip faults in accretionary prisms (Moore & Vrolijk, 1992). Fluids originate from sediment consolidation, mineral dehydration and methane and carbon dioxide generation from organic matter. Sediments incorporated within tectonic belts, however, often underwent a complex diagenetic evolution during burial and most waters have already been expelled before tectonic deformation. Within such a setting fluids are mainly derived from diagenetic and especially metamorphic reactions. High fluid fluxes are only attained when synorogenctic faults intersect the metamorphic basement. Flow regimes evolve from conditions of high P-T with locally derived fluids during initiation of the structures, to high fluxes of metamorphic fluids as the structures propagate and intersect the fluid reservoirs (Kerrich *et al.*, 1984). The aim of this study is to document the palaeofluid flow at the Variscan thrust front in Belgium and western Germany. The criteria and techniques used to distinguish open from closed fluid flow systems are presented together with numerical simulations of the temperature field within an open fluid flow system.

The Variscan Front Complex is made up of a series of thrust sheets at the Variscan thrust front. In eastern Belgium and western Germany, this thrust front is characterised by a strongly imbricated zone and a greenschist metamorphic area to the south. Associated with this imbricated zone, locally anomalous high coalification values occur in the Upper Carboniferous sediments. This anomaly is also suggested by the high homogenisation temperatures (up to 210°C) of low salinity H_2O-NaCl fluid inclusions in Variscan quartz veins (Stroink, 1993). Similar H_2O-NaCl fluids are present as inclusions in quartz veins associated with large thrust faults within the metamorphic area to the south. Chlorite geothermometry indicates similar high precipitation temperatures (>300°C) of cements in shear veins over a vertical distance of more than one km at the thrust front. These thermal anomalies, which show a close relation to the tectonic setting, indicate that fluid flow in an open system caused these elevated temperatures and the strong spatial differences. The fluids could have originated from the metamorphic zone to the south. To test this model, the palaeotemperature field has been simulated numerically. This 2D modelling of the thermal field incorporates heat transport by fluid flow and by thermal conduction. It confirms the significance of long distance fluid migration along high permeable fault zones at the Variscan thrust front in eastem Belgium and western Germany.

Variscan veins, which formed during folding, at other parts of the Variscan thrust front formed from a fluid which was geochemically buffered by the host-rock (Muchez *et al.*, 1995) and in thermal equilibrium with it. This indicates a closed system, with fluids and components derived from the adjacent wall-rocks. The presence of the metamorphic basement and the frontal thrust splay in eastern Belgium and western Germany seem to provide the necessary fluids and migration pathways.

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FLUID EVOLUTION DURING THE VARISCAN OROGENY: VARIATION IN PRESSURE, TEMPERATURE AND COMPOSITION

Kristof SCHROYEN & Philippe MUCHEZ[1]

1. Fysico-chemische Geologie, K.U.Leuven, Celes-tijnenlaan 200C, B-3001 Heverlee

The Stavelot-Venn Massif consists of Lower Palaeozoic strata (Lower Cambrian to Middle Ordovician), which are unconformably overlain by the Devonian and Carboniferous. This massif underwent two main orogenic phases: a Caledonian one with a probable very low-temperature metamorphism and a pronounced Variscan stage. The southern border of the Stavelot Massif underwent a Variscan greenschist facies metamorphism with an estimated temperature and pressure range of 360-420°C and 100-200 MPa respectively. Numerous thrust faults crosscut both the Lower and Upper Palaeozoic strata and have consequently a Variscan age, though they could have a Caledonian origin. Quartz-chlorite veins, associated with the different thrust faults, have been examined to deduce the source and physico-chemical (P-V-T-X) evolution of the fluids from which these minerals precipitated. Prograde metamorphism causes devolatisation reactions of minerals, which can produce a regional metamorphic fluid. The properties of this fluid can vary in space and time due to other factors like other infiltrating fluids (metamorphic, meteoric, magmatic), prolonged contact with the host-rock, and faulting, which can provide pathways for the different types of fluids. It is also commonly observed that vein sets are reactivated during orogenic events. The aim of this study is to reveal the relationship between faulting, fluid flow and metamorphism. The most powerful tools in characterising P-V-T-X properties are microscopic examinations and fluid inclusion studies.

Optically, several distinct stages of quartz formation could be recognised and a detailed paragenesis has been constructed. Microthermometric studies of the different stages revealed two-phase primary inclusions with a H_2O-NaCl-CO_2 and a H_2O-NaCl composition. Some of the more deformed quartz crystals also contain primary CO_2-N_2 inclusions. The primary inclusions are cut by secondary H_2O-NaCl inclusions. Total homogenisation temperatures of the primary H_2O-CO_2-NACl and H_2O-NaCl inclusions range trom 300°C to 415°C. These temperatures are similar for the different paragenetic stages. Salinity ranges between 2.2 and 6.9 eq.wt.% NACl. Secondary inclusions homogenise between 150°C and 22°'C and have very low salinities. Bulk fluid densities and isochores of the inclusions were calculated with the computer program FLINCOR. The geochemical investigation of chlorites, which are intergrown with quartz, provides an estimate of the temperature of chlorite formation. From empirical and thermodynamic geothermometric models, precipitation temperatures between 380°C and 435°C can be calculated. These data are used to deduce the P and T range during vein formation by crossing relationships between fluid isochores and precipitation temperatures in P-T diagrams. The calculated pressures are between 130 MPa and 280 MPa, at a temperature range of 300°C to 435°C. It has to be noted that along the thrust faults, a horizontal variation in pressure and temperature is recognised. For the studied region, local fluctuations in P and T can be explained by the rigidity of older competent strata in the region. Higher pressures and temperatures occur where the thrust faults strike against these rigid blocks.

Low salinity H_2O-CO_2-NACl fluids are commonly recognised in metamorphic terrains and are believed to originate from devolatisation reactions of minerals, eventually influenced by local fluid-rock interactions. CO_2 and N_2 on the other hand are likely generated early in the maturation history of a sedimentary basin due to the breakdown of nitrogen-rich phyllosilicates. Their presence in the oldest, most deformed quartz crystals could indicate a relic fluid.

In general, the interpreation of the P-T results can be three-fold:

(1) rapid upward flow of an overpressured fluid along a thrust fault;
(2) pressures of local metamorphic fluids are higher than the (estimated) lithostatic pressures;
(3) fluid pressures are 'near lithostatic' but at a higher pressure range (130-280 MPa) than the general estimate (100-200 Mpa).