THE PRE-HERCYNIAN EVOLUTION OF THE IBERIAN CRUST ON THE BASIS OF CONVENTIONAL AND ION-MICROPROBE U-PB DATA

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Situated at the southwesternmost rim of the European Hercynides, the Iberian Peninsula contains the largest of the usually strongly disrupted pre-Mesozoic crystalline massifs of Hercynian Europe. With its classical fan-like arrangement exhibiting the most complete cross section within the European Hercynides, the Iberian Massif displays promising conditions for the study and reconstruction of the pre-Hercynian geodynamic evolution. One of its tectonometamorphic subunits, the Ossa Morena Zone carries a key position for unravelling its geological history as the partly penetrative Hercynian overprint is predominantly concentrated along both of its margins.

Primary magmatic ages of rocks older than around 700 Ma are rare within the whole European Hercynides. Information documenting a long pre-history of the material which forms the Iberian crust, is given by Nd crustal residence ages between 1.8 and 2.0 Ga on finegrained pre-Permian and Late Pan-African sediments of the Iberian Massif (Nägler, 1990) that suggest the existence of Early Proterozoic and probable Archean components. These model ages reflect mixing of differently old crustal components newly formed from the mantle. Comparable crustal "ages" (1.9 Ga) are only recorded for sediments of similar ages from Brittany, whereas the model ages of coeval sediments from other parts of the European Hercynides are younger (1.7-1.6 Ga; Michard et al., 1985; Liew and Hofmann, 1988).

Conventional and ion-microprobe (SHRIMP I+II) analyses on zircons extracted from different rock types of the Iberian Massif were carried out in order to (1) achieve detailed information on provenance ages and regional stratigraphy and to (2) constrain the geological evolution in the respective areas. For the first, depositional ages obtained on detrital zircon population and for the latter, magmatic and metamorphic ages as obtained by U-Pb dating were interpreted. Cathodoluminescence studies on the zircon mounts used for SHRIMP dating allowed to differentiate between both magmatic and metamorphic zircon domains that were than dated individually.

Detrital zircon populations of metasediments contain zircon or zircon domains up to an Early Archean age of 3.4 Ga, which is the oldest age obtained so far from the Iberian Massif. Further SHRIMP-data define ages clustering at 2.4-2.0 Ga, 1.0 Ga, 0.7-0.6 Ga. Primary-magmatic ages of the youngest zircon grains yielded ages between 515 and 550 Ma and thus, the maximal depositional ages for the respective sediments (Malcocinado Formation, Bodonal Cala Complex, Montemolin Group) are remarkable younger than their stratigraphically derived Vendian to Upper Riphean ages – a result previously also found for the Tentudia Group (Schäfer et al.,1993a). Although still preliminary, similar Pan-African ages have been derived from metasediments from Galicia (Cabo Ortegal and related complexes; Schäfer et al.,1993b). These data as well as the Nd crustal residence ages suggest that the Iberian Massif consists of and/or is recycled in part from older, i.e. from more internal fragments of the super-continent Gondwana.

Conventional U-Pb zircon, monazite and xenotime dating on a tectonomagmatic diverse assemblage of granitoids as well as additional SHRIMP-data on varying rock types enable the recognition of a well-defined sequence of magmatic events related to a preHercynian orogeny (Upper Proterozoic-Lower Paleozoic) and its subsequent transition to an intracontinental rift-regime. Spanning a time interval of at least 150 Ma from ca 620 Ma up to 470 Ma, the geochronological data enclose a complete pre-Hercynian and, further, the onset of a new Wilson cycle. Different magmatic belts with a broad zonation in time and space can be distinguished, each characterized by distinct tectonomagmatic affnities and, furthermore, representative for a particular stage of the pre-Hercynian orogen as well as of the transition to a following rift-regime. Although magmatic events are considered to record a continuum of orogenic processes, six magmatic episodes can be distinguished: (1) an early anorogenic stage (~620 Ma, still tentative), (2) a subduction-related calc-alkaline stage (590-540 Ma, poorly established), (3) a syn-orogenic peraluminous stage (530 Ma), (4) a late-orogenic calcalkaline stage (525-510 Ma), (5) a late-orogenic alkaline stage (500 Ma) and (6) again an anorogenic, rift-related stage (480-470 Ma) reflecting the onset of a new cycle. In particular the high density of ages on magmatic events during late-orogenic processes and the subsequent intracontinental rift–regime is unique within the Avalonian–Cadomian–PanAfrican realm allowing for the first time to give detailed predictions about pre–Hercynian (end–)orogenic geodynamic processes. This fact underlines the importance of the OssaMorena Zone to be one of the particular areas within the Avalonian–Cadomian–Pan–African realm to unravel the Upper Proterozoic–Lower Paleozoic orogenic evolution.

A synthesis of the currently available geochronological data envisages a geodynamic framework for the pre–Hercynian orogenic belt of the Ossa–Morena Zone resulting from a progressive cratonization of a magmatic arc and marginal basin system. According to the petrochemistry of respective granitoids and the nature of associated (volcano)sedimentary successions and related mafic rocks, an active continental margin setting is the most likely geotectonic scenario for the evolution of the pre–Hercynian orogen. The balance of geological evidences, however, does not correspond with classical models of orogenic belts, i.e. where a continent–continent collision with consequent crustal thickening and uplift terrninates an initial stage of oceanic lithosphere subduction and finally leads to a period of stabilized continental lithosphere. The good state of preservation of the magmatic arc, a low metamorphic grade of the pre–Hercynian basement at the present erosion level and absence of thick, late–orogenic molasse–type sedimentary successions argue against a continent–continent collision model including major crustal thickening and high uplift rates. As similarly proposed for other Upper Proterozoic–Lower Paleozoic orogenic belts of the Avalonian—Cadomian—Pan–African realm, a rifted magmatic arc complex therefore mirrors best the geodynamic/geotectonic setting of the pre–Hercynian orogen in the Ossa–Morena Zone. A continuously changing stress regime from cornpressive/transpressive to transcurrent/transtensive tectonism is likely the motive power for the observed sequence of magmatic events. Hence, the cessation of subduction–related magmatic activity is not the consequence of a complete destruction of a former oceanic crust causing a continent–continent collision and crustal thickening but is related to a transition of the compressive setting to an intracontinental shear zone. Although genetically linked to the pre–Hercynian orogeny, magmatic activity of the rift setting and rebuilding of platform conditions mark the inception of a new Wilson cycle.

The lack of a widespread Lower Paleozoic basic magmatism suggests that, subsequent to the ensialic intracontinental rifting episode, no significant oceanization process at the site of previous alkaline magmatic formations occurred. This supports the existence of several distinct minor distensional zones and argues against a concept of large oceanization. Faunal and facies analyses of Lower Paleozoic sedimentary sequences additionally underlined the absence of wider oceanic domains. Recorded faunal similarities provide evidences for the existence of a stable cratonic West European Platform whose intracratonic basins did not act as important faunal barriers. On the contrary, faunal and facies data are indicative for intracontinental rift zones and associated basins to be deep enough to introduce deeper biofacies but not wide enough to induce major changes in endemicity.

PEROVSKITES AND SILICIA SATURATED SYSTEMS – TWO NATURAL ANTAGONISTS?

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Generally the crystallisation of Perovskites takes place in basaltic to alkalic, silicia undersaturated magmas. In a silica – saturated enviroment the crystallising Ti–phase is commonly Titanite. The presence of both Ti–phases is often explained. by two different crystallisation generations with changed crystallisation conditions. The examination of the phase relations and trace element distribution in the system $CaAl_2Si_2O_8$ (An) – $CaMgSi_2O_6$, (Di) – $CaTiSiO_5$ (Ti) evaluated some aspects for the Perovskite genesis in complex magmatic systems. All experiments were carried out within the composition plane of the three minerals with trace element–dopping at levels smaller than 5000 ppm. Crystallisation at nearby liquidus conditions (±5 °C) and rapid quenching allows the preparation of samples which show coexisting minerals – liquid pairs from mixtures of pseudoeutectic compositions. The surrounding system Anorthite – Titanite with and without trace elements is of special interest for Perovskite growth.