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SHORT NOTE

Back to sender: tectonic accretion and recycling of Baltica-derived Devonian clastic sediments in the Rheno-Hercynian Variscides

Wolfgang Franke[1] · **Joachim-Christian Dulce**[2]

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Abstract Sedimentary petrography and zircon ICP-MS laser ablation ages from synorogenic clastic sediments in the Rheno-Hercynian Belt of Germany (Rheinisches Schiefergebirge, Harz) reveal basal tectonic accretion followed by exhumation and recycling of Baltica-derived Devonian shelf sediments. The recycled sediment volume demands a substantial palinspastic addition to the passive, northern margin of the Rheno-Hercynian basin. Detrital zircon ages from the Late Carboniferous foreland basin and their possible source rocks in the South Portuguese Zone permit the same interpretation. This suggests that synorogenic sedimentation in Portugal is related, like in Germany, to the closure of the Devonian-Carboniferous Rheno-Hercynian basin and not to the closure of the Ordovician–Silurian Rheic Ocean.

Keywords Variscides · Rheno-Hercynian Belt · Syn-orogenic clastic sediments · Mineral composition · Detrital zircon · ICP-MS laser dating

Rheno-Hercynian Belt in Germany: general setting

As laid out in summaries in Dallmeyer et al. (1995), and Franke (2000, 2006), the Rheno-Hercynian Belt (Fig. 1) resulted from the closure of a sedimentary basin which opened in Early Devonian time, subsequent to the closure of the Rheic Ocean. Opening of the Rheno-Hercynian successor to the Rheic was probably brought about by south-eastward subduction of the Rheic mid-ocean ridge under the northern margin of the Armorican Terrane Assemblage (ATA), thus separating a ribbon of Armorican rocks from the Armorican mainland to the south-east—a process reminding the Bay of California. The rift stage of the basin is documented in Early Devonian shelf sandstones. Key outcrops are situated within a narrow belt of pressure-dominated greenschist-grade rocks at the south-eastern margin of the Rheinisches Schiefergebirge and Harz Mts. (Northern Phyllite Zone, NPZ). Within the NPZ, Early Devonian clastic sediments unconformably overly, in order from west-south-west to east-north-east, Avalonian crystalline basement, a Silurian–Early Devonian magmatic arc marking the Rheic suture and early Ordovician metapelites attributed to Armorica, thus sealing the Rheic suture. Tait et al. (2000) summarized palaeomagnetic data from the Variscides and concluded that the Rheic Ocean was closed by the Early Devonian. Biogeography proves closure of the Rheic in time between the Gedinnian and the Frasnian (McKerrow et al. 2000), which is in accord with the Early Devonian clastic onlap across the Rheic suture. In the Rheno-Hercynian allochthon, Ordovician and Silurian sedimentary rocks with Armorican affinities are contained in Early Devonian turbidites and debris flow deposits relating to Rheno-Hercynian extension. Together, these observations prove that the pre-Devonian rocks of the Rheno-Hercynian belong to an older (Rheic) orogenic cycle. The Rheno-Hercynian suture is marked by MORB-type metabasalts and metapelites along the south-eastern margin of the NPZ.

Closure of the younger, Rheno-Hercynian narrow ocean is documented in Frasnian through to Westphalian

✉ Wolfgang Franke
w.franke@em.uni-frankfurt.de

1 Inst. für Geowissenschaften, Goethe-Universität, Altenhöferallee 1, 60438 Frankfurt am Main, Germany

2 ExxonMobil Production Deutschland GmbHRiethorst 12, 30659 Hannover, Germany

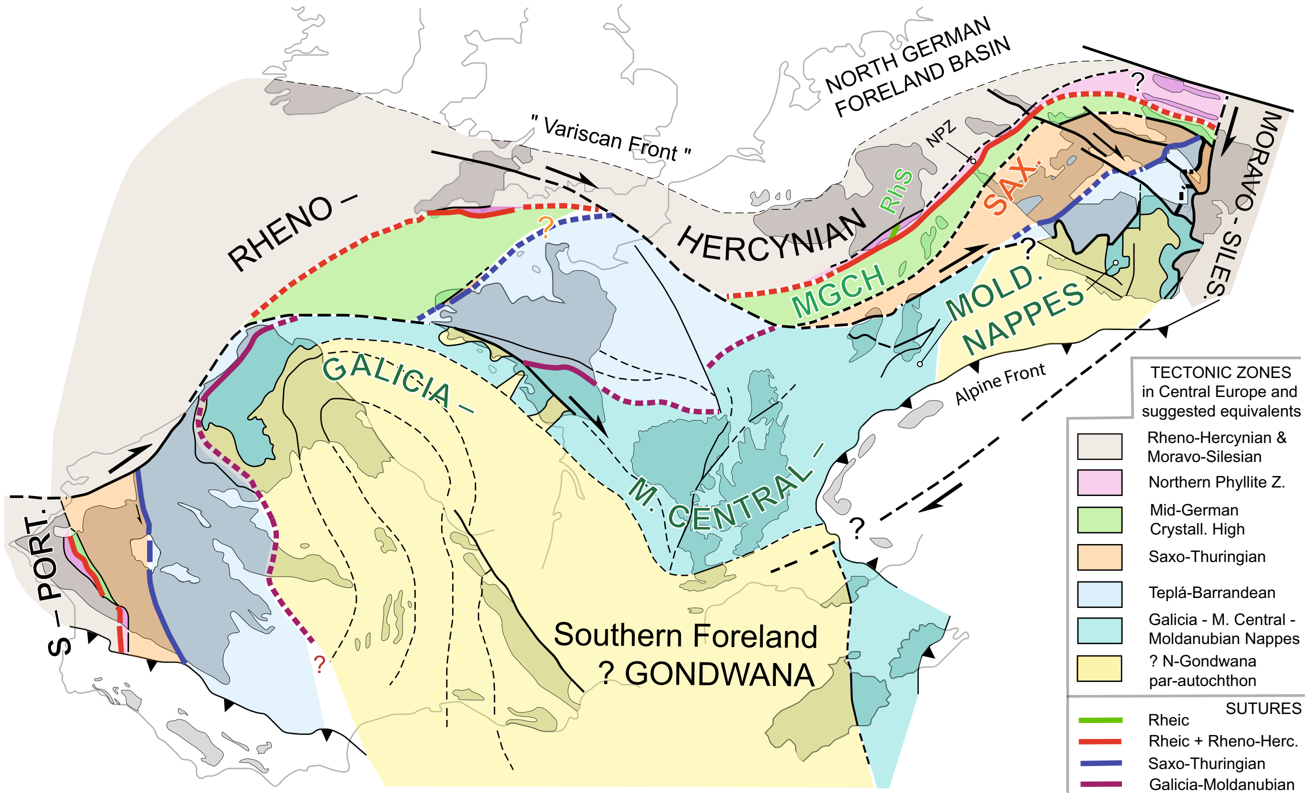

Fig. 1 Tectonic and palaeogeographic map of the Variscides (simplified after Franke 2014). *NPZ* Northern Phyllite Zone in Germany and structural equivalents elsewhere; *RhS* Rheic suture; *SAX* Saxo-Thuringian Zone; *S-Port*. South Portuguese Zone

synorogenic clastic sedimentation prograding towards the north-west. In the allochthonous units, sedimentation of greywacke turbidites starts in the Early Frasnian and continues into the Viséan. In the autochthon, first turbidites are observed from the late Tournaisian onwards and are succeeded by paralic, coal-bearing sandstones deposited during the Namurian C to Westphalian D (see the summaries in Engel and Franke 1983; Franke and Engel 1986; Franke 2000; Huckriede et al. 2004).

Rheno-Hercynian synorogenic clastic sediments: composition and detrital zircon ages

Rheno-Hercynian Belt in Germany

Engel et al. (1983a) have shown that the quartz/feldspar ratio in the synorogenic clastic sediments increased rapidly during the latest Viséan and stayed high during the rest of the Carboniferous (Fig. 2). This trend is accompanied by a change in the clast spectrum from crystalline rocks to sandstones of varying metamorphic grade (Wachendorf 1965). Engel et al. (1983a) have explained these findings by frontal tectonic accretion of Baltica-derived Devonian shelf sandstones to the southern, active margin that fed the foreland basin. Important progress made in the understanding of Rheno-Hercynian tectonism and its timing permits to define possible source regions and mechanisms of accretion more precisely (see below).

Petrological studies of Late Carboniferous sandstones from the North German foreland basin have confirmed the predominance of quartz over feldspar and of quartz-rich (meta-)sediments over granitoids and gneisses (Massonne 1984; Holl and Schäfer 1992; Kraft 1992). According to these authors, ≥50% of the Late Carboniferous sandstones consist of recycled siliciclastic material.

The recycling model of Engel et al. (1983a) has recently been supported by an extensive study of Laser-ICP-MS detrital zircon ages from the Upper Carboniferous of northern Germany (Franke 2008, unpublished report to ExxonMobil; Franke 2013). Ca. 3400 zircon grains from 40 samples in 11 localities yielded fairly uniform age spectra (Figs. 3, 4). Analytical data will be published in a later paper covering the entire range of synorogenic clastic sediments.

Grains ≤650 Ma with less than 10% discordance reveal peaks around 310 Ma (Variscan magmatism and metamorphism), 430 Ma (Caledonian Belt of Laurussia or Silurian

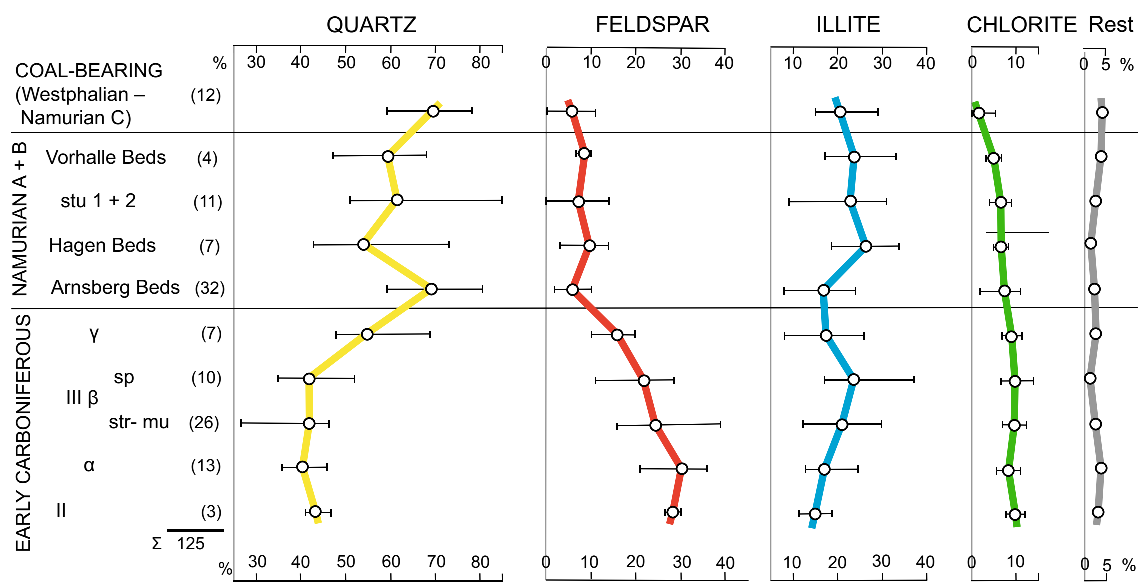

Fig. 2 Mineral composition of Rheno-Hercynian synorogenic clastic sediments in the Rheinisches Schiefergebirge (infrared spectroscopy, after Engel et al. 1983a). "Rest": heavy minerals and carbonates

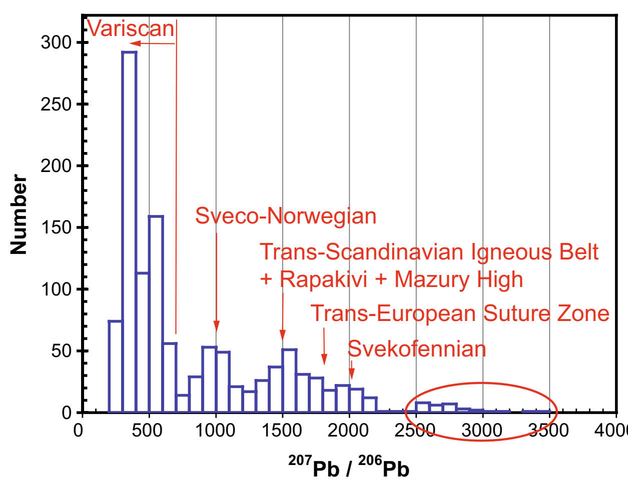

Fig. 3 Laser ICP-MS ages (x-coordinate, in Ma) of detrital zircons from Late Carboniferous (Namurian C through to Westphalian D) from the northern margin of the Rheinisches Schiefergebirge, Teutoburger Wald and (confidential) wells in northern Germany: age spectrum of grains ≤10% discordance and their possible derivation (from Franke 2008, unpublished report to ExxonMobil). Ellipse: zircons derived from Karelia or Sarmatia, or recycled into younger granitoids or sediments. Interpretation of Baltic sources after Bogdanova et al. (2015) and Valverde-Vaquero et al. (2000)

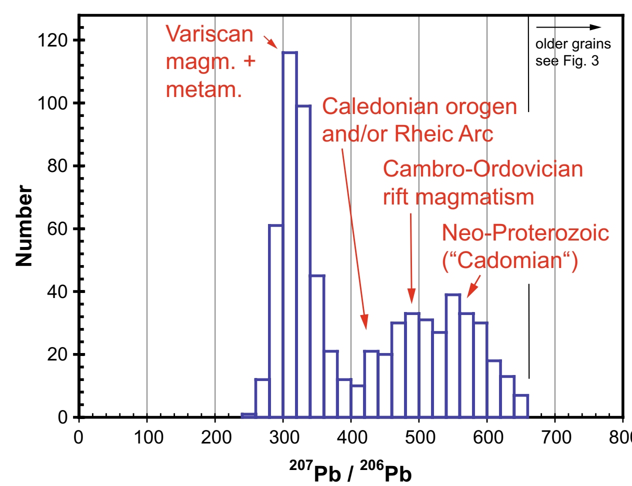

Fig. 4 Laser ICP-MS ages (x-coordinate, in Ma) of detrital zircons from Late Carboniferous sandstones (Namurian C through to Westphalian D) from the northern margin of the Rheinisches Schiefergebirge, Teutoburger Wald and wells in northern Germany: possible derivation of grains with ≤10% discordance ≤650 Ma (from Franke 2008, unpublished report to ExxonMobil)

Arc at the southern margin of the Rheinisches Schiefergebirge, Franke 2000; Zeh and Will 2010), around 500 Ma (Cambro-Ordovician rift magmatism) and around 550 Ma (Neo-Proterozoic "Cadomian" orogeny). In addition, there are older clusters of near-concordant ages around 1, 1.5, 2.0 and 2.5–2.8 Ga, which can be can be attributed to various sources in Baltica (see Fig. 3; compare, e.g. Bogdanova et al. 2015; Valverde-Vaquero et al. 2000).

The persistent occurrence of these pre-Cadomian grains in all analysed samples is surprising, since sedimentary structures, facies and subsidence patterns in the Late Carboniferous sandstones consistently reveal derivation from the south-east and current directions towards the south-west (Casshyap 1975; Frank et al. 1992; Holl and Schäfer 1992; Massonne 1984; Suess 1996). That southerly derivation is underlined by Carboniferous sandstones from the Oslo Graben which have only yielded Variscan zircon ages (Dahlgren and Corfu 2001). The same applies to Asturian (Late Westphalian) coal measures in southern Scotland, whose zircon spectrum is clearly dominated by Variscan sources (Morton et al. 2010). Few possibly Baltica-derived zircons are considered by these authors to have been recycled from underlying north-derived sandstones. Together, these findings reveal that there was no sediment-producing high on the northern shore of the Carboniferous foreland basin. Therefore, accreted Baltica-derived Devonian sandstones are the only possible source for the zircon spectra of the south-derived Rheno-Hercynian synorogenic clastic sediments.

Late Devonian through to Viséan greywacke turbidites from Rheno-Hercynian allochthonous units have not yielded Baltica-derived zircons (Eckelmann et al. 2014). This is in accord with the observation of Engel et al. (1983a) that accretion and recycling of Devonian sandstones started in late Viséan time.

Other parts of the Rheno-Hercynian Belt

In the *subsurface of Poland between Wrocław and Warszawa*, late Viséan through to Westphalian turbidites have only yielded late Devonian and Carboniferous detrital zircon ages (Mazur et al. 2010). In the *Moravo-Silesian Belt* (Fig. 1), the main part of Viséan flysch was derived from low-grade metamorphic rocks, granitoids and partly recycled sediments (including Early Carboniferous limestones), before detritus from the exhumed Moldanubian Granulites became available in the latest Viséan (Fiala and Patocka 1994, Schneider et al. 1999, Hartley and Otava 2001). Earlier parts of the Moravo-Silesian flysch contain white micas with late Devonian Ar/Ar ages (Schneider et al. 1999). In *South-West England*, there is no information on the ages of detrital zircons and white micas from synorogenic clastic sediments.

The *South Portuguese Zone (SPZ)* of SW Iberia is generally acknowledged as the south-westernmost segment of the Rheno-Hercynian Belt (Fig. 1). Since the south-western part of the Central-Iberian Zone correlates with the Armorican Massif (discussion and refs. in Franke 2014) and the latter with the Teplá-Barrandian block of the Bohemian Massif (Fatka and Mergl 2009), it is plausible to also correlate the intervening belts (Saxo-Thuringian Belt of Germany and Ossa Morena Zone of Iberia). The northern resp. south-western parts of these belts (Mid-German Crystalline High, Aracena metamorphic belt) have undergone higher grade metamorphism and deformation and can be interpreted as segments of the southern, active margin of the European Rheno-Hercynian basin.

In the South Portuguese Zone, outcrops of Devonian rocks are limited, but Famennian shallow-marine clastic sediments and carbonates (Phyllite-Quartzite Group and Tercena Fm., see Oliveira 1990 and García-Alcalde et al. 2002) remind the Late Devonian shelf sediments of the north-western Rheinisches Schiefergebirge. The Carboniferous synorogenic clastic sediments and the Late Devonian/Early Carboniferous volcanic rocks of the "Pyrite Belt" of the South Portuguese Zone have close equivalents in SW England and Germany (see Oliveira et al. 1979; Engel et al. 1983b). Similar to the Rheno-Hercynian counterpart in Germany, synorogenic sedimentation prograded towards the foreland in Late Devonian through to Early Westphalian time (Oliveira 1990), and the mineral composition changes from greywackes to immature quartzites. Oliveira et al. (1979) explained this trend by multiple recycling of clastic material at the tectonic front.

ICP-MS laser dating of zircons from Early and Late Carboniferous synorogenic clastic sediments (Rodriguez et al. 2015) has yielded a predominance of ages between 388 and 316 Ma in the Mértola and Mira Formations (late Viséan—Namurian), while ages between 687 and 498 Ma prevail in the Brejeira Formation (late Bashkirian—late Moscovian = early Westphalian). While the above age groups accord with derivation from the active, north-eastern (present-day coordinates) margin of the South Portuguese foreland basin and its hinterland, the Brejeira Fm. has also yielded age clusters taken to represent Avalonia or Meguma-type basement sources (Grenvillian, c. 1 Ga; see also Pereira et al. 2014). Braid et al. (2011) have published detrital zircon ages from pre-Givetian clastic sediments of the Pulo do Lobo unit, the most internal part of the South Portuguese belt which also suggest derivation from Laurussian sources (peaks around 1–1.3, 1.4–1.9 and 2.5–2.8 Ga, see Fig. 5 and the discussion below).

Discussion

Accretion and recycling of Baltica-derived clastic sediments

Accretion of Laurussia-derived Devonian clastic sediments to the active margin of the *Rheno-Hercynian Belt in Germany* is clearly demonstrated by increasing maturity of the synorogenic clastic deposits from the Late Viséan onwards, by a concomitant change from crystalline towards (meta-)sedimentary detritus and by the presence of Baltica-derived detrital zircons. Zircon age spectra of a Siegenian sandstone from the Rhenish Massif (Eckelmann et al. 2014, (1) on Fig. 5) and an? Early Devonian metamorphosed quarzite from the north-western Harz Mts. (Geisler et al. 2005, (2)

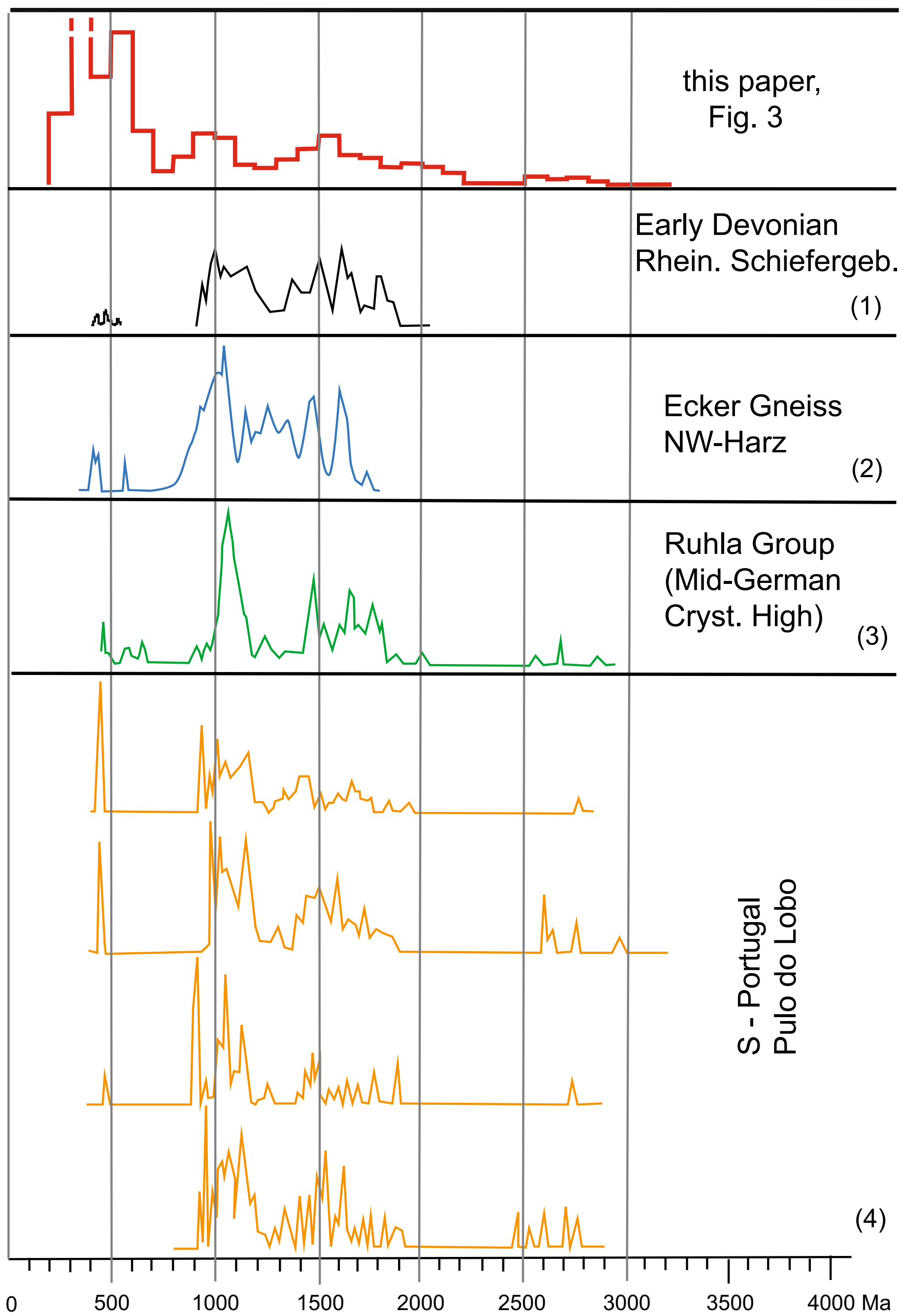

Fig. 5 Comparison of detrital zircon populations from Late Carboniferous rocks (this study), Siegenian sandstones of the Rhein. Schiefergebirge (*1*, Eckelmann et al. 2014), the Devonian Ecker Gneiss (Harz Mts. (*2*, Geisler et al. 2005), quartzites of the Ruhla Group (*3*, Mid-German Crystalline High, Zeh and Will 2010) and Devonian clastic sediments of the Pulo do Lobo Unit (*4*, S-Portugal, Braid et al. 2011). Note that the ordinate axes of the frequency diagrams have different scales

on Fig. 5) are similar to those found in the Late Carboniferous sandstones. Recycling of passive margin deposits detached from the foreland is a well-known process, also in other parts of the Variscides (e.g. Engel et al. 1981; Schäfer et al. 1997).

Detrital white mica fractions from Early and Late Carboniferous clastic sediments (Huckriede et al. 2004; Neuroth 1997; Küstner 2000) do not reveal Laurussian sources. However, this observation does not invalidate the above interpretation of the zircon record, because a) mica ages in the source rocks could have been reset by Variscan metamorphism prior to their recycling, b) minor quantities of Baltica-derived micas mixed with Variscan detritus are not detectable and c) Baltica-derived micas might have been destroyed during the second cycle of erosion and transport.

Devonian clastic sediments from external areas of the Rheno-Hercynian Belt (1, 2 on Fig. 5, see above) were not available for recycling: the Ecker Gneiss of the north-western Harz Mts. with its Early Devonian and older zircons (Geisler et al. 2005) was uplifted in the roof of a Permian gabbro, and the extensive present-day outcrop of Devonian shelf sandstones in the Rheinisches Schiefergebirge was brought about by a Cenozoic mantle plume centred around the middle Rhine Valley (Fuchs et al. 1983). The possible exposure of Devonian sandstones during Carboniferous times is best assessed from the outcrop pattern at the eastern margin of the Schiefergebirge. Along most of that margin, Early and Middle Devonian clastic sediments are sealed by a continuous cover of Late Devonian and Carboniferous deposits. Devonian clastic sediments were only available for erosion from areas south of the Taunus Thrust, where bedding is subvertical (e.g. Oncken 1988, 1997) or in areas further south, including the Mid-German Crystalline High. The Taunus unit and the Northern Phyllite Zone south of the Taunus Thrust qualify as source areas only in time after the formation of cleavage in these units (around 318 Ma and 323 Ma; K/Ar: Klügel 1997), i.e. after the the mid-late Namurian (time scale: Davydov et al. 2010; Waters and Condon 2012). These age relations preclude uplift and erosion at the southern margin of the Rheinisches Schiefergebirge during the early phase of recycling (latest Viséan and early Namurian).

However, quartzites with Baltica-derived zircons occur in the Ruhla segment of the Mid-German Crystalline High (Zeh and Gerdes 2010; Zeh and Will 2010, on Fig. 5) and closely resemble those of the Early Devonian (Siegenian) Taunus Quartzite of the southern Rheinisches Schiefergebirge (Zeh and Gerdes, cited in Zeh and Will 2010). The Hahnenkamm Qzt. of the northern Spessart Mts. in the Mid-Germany Crystalline High is another candidate for recycling. The Silurian spores described by Reitz (1987) might be reworked, so that a Devonian age is possible. Ar/Ar and K/Ar cooling ages of micas from the eastern Odenwald and Ruhla segments partly range between ≥360 and 330 Ma (Zeh and Will 2010). Hence, eroded parts of rock units now contained in the Mid-German Crystalline High are a plausible source for the recycling of Baltica-derived detritus from the late Viséan onwards. In summary, it appears that the Baltica-derived material recycled into the Carboniferous foreland basin was not positioned at the front, but at the base of the orogenic wedge, from which it was exhumed after a prolonged PT path (see Fig. 6 and Oncken 1997).

Towards a mass balance of recycled material

The Late Viséan onset of accretion of sandstones will have to be controlled and narrowed down by ongoing zircon studies. A complete record of detrital zircon populations together with mineral composition data will allow to estimate the volume of recycled shelf deposits.

A preliminary estimate (sketched out below) is based upon the isopach maps for the Namurian and Westphalian published by Drosdzewski and Wrede (1994). For these time intervals, the contours of the basin define rectangular triangles. The south-western and south-eastern basin margins are steep, while thickness is observed to wedge out towards the north-east, so that the basin fill can be modelled as a tetrahedron. This operation yields a total sediment volume of c. 635 000 km^3, of which ≥50% (≥317 000 km^3) have been interpreted to consist of recycled clastic sediments. Transformation into 2-D (recycled part of basin volume divided by the length of the south-eastern basin margin, 900 km) yields the cross-sectional area of the basin (c. 350 km^2). Division of that cross section by the thickness of the recycled Devonian clastic sediments (c. 2000 m, Oncken 1988; Dittmar 1996; Klügel 1997) yields the palinspastic width of the eroded part of the passive margin (175 km). Although all of these figures have error bars requiring detailed discussion, the above estimate demonstrates that the recycled part of the Devonian shelf is a sizeable addition to the palinspastic reconstruction of the Rheno-Hercynian passive margin as presented in Doublier et al. (2012).

Other parts of the Rheno-Hercynian Belt

The apparent absence of Baltica-derived detritus from the *sub-surface Carboniferous flysch of Poland* could either be due to the lack of recyclable Devonian shelf sediments or to the tectonic setting, which was dominated by dextral displacement along the south-western margin of Baltica (Franke and Żelaźniewicz 2002).

In *South Portugal*, Pereira et al. (2014) and Rodriguez et al. (2015) have interpreted the Avalonia/Meguma-type zircons in the Late Carboniferous Brejeira Fm. as being derived from basement rocks originally exposed at the external, south-western basin margin or along an intra-basinal high. However, similar zircon age clusters from metasediments in the Pulo do Lobo unit (Fig. 5) remind the spectra of the Baltica-derived zircons in Early Devonian shelf clastics at the southern margin of the Rheno-Hercynian Belt of Germany and their recycling into the Late Carboniferous flysch. Direct derivation from basement exposed in the passive margin or an intra-basinal high (see above) appears unlikely, because that basement, in Late Carboniferous time, should still have been covered by Early Carboniferous and Devonian sediments.

The Rheic paradox

The Rheic suture between Avalonia and the Armorican Terrane Assemblage is situated at the south-eastern margin of the Rheinisches Schiefergebirge (see above) and equivalent areas in south-west England and south-west Iberia. This has mislead numerous authors to explain the Rheno-Hercynian fold and thrust belt by closure of the Rheic Ocean

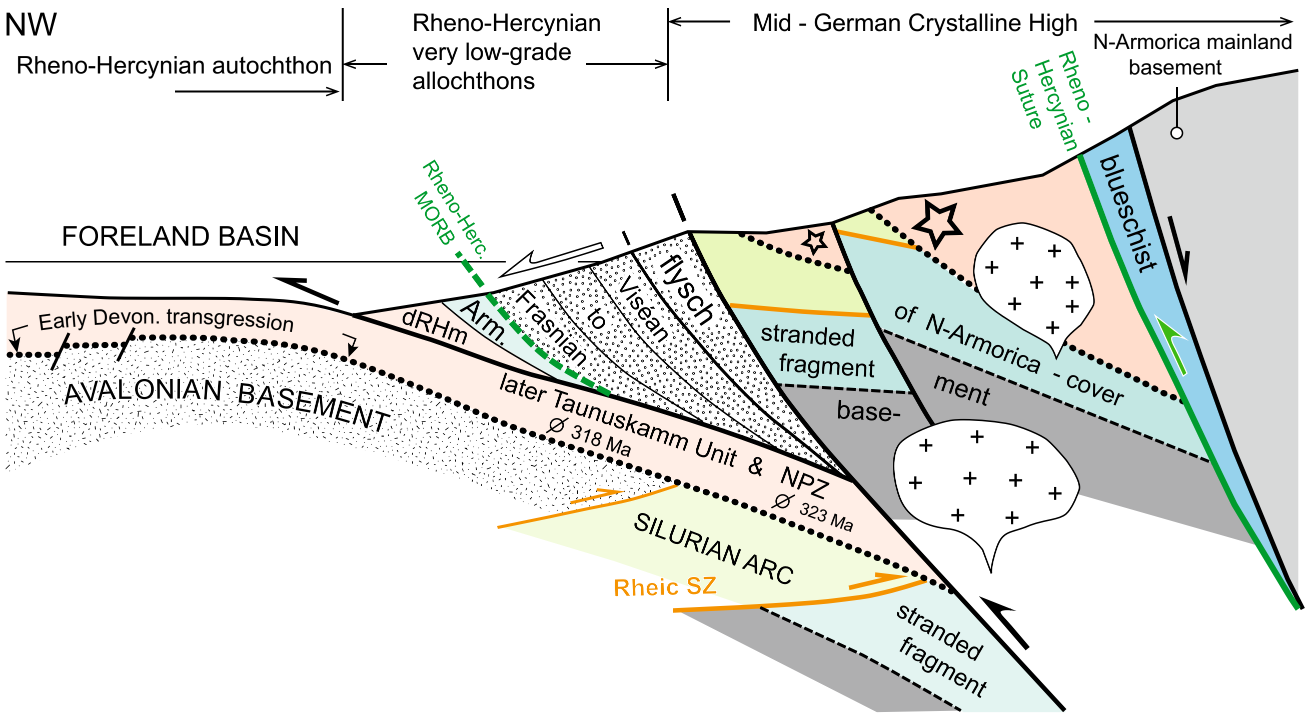

Fig. 6 Conceptual tectonic section of the Rheno-Hercynian orogen (Spessart segment of Mid-German Crystalline High, MGCH, and foreland) showing the palaeogeographic derivation of the tectonic units, at c. 330 Ma (Viséan/Namurian boundary). Underplated basement units after Franke (2000) and Oncken (1997). Blueschist unit inserted after findings of Gansslosser et al. (1996), interpreted as the source of c. 380 Ma phengitic detrital micas (Huckriede et al. 2004). More intense colour shades in MGCH indicate higher grade of Variscan metamorphism due to underplating, as opposed to the frontally accreted allochthonous rocks. Stars: proposed source regions of Baltica-derived metamorphosed Devonian clastic sediments. dRHm: sediments of distal, northern margin of Rheno-Hercynian basin; Arm: Ordovician quartzites (near-shore facies of the northern, passive margin of Armorica). Numbers in underplated rocks (Taunuskamm unit and Northern Phyllite Zone, NPZ, to be exhumed later) are mean K/Ar ages on s_1 slaty cleavage (Klügel 1997). Greenschist-grade Armorican sediments in S-Harz segment of NPZ have been dated at 351–341 Ma (Ahrendt et al. 1996). Note that the MGCH—depending on topography and the state of thrusting—may also have sourced metamorphosed Silurian Arc rocks, early Palaeozoic Armorican sediments and their basement (Armorican fragment stranded N of the Rheno-Hercynian suture), granitoids and Armorican basement of the Rheno-Hercynian upper plate

(e.g. Pereira et al. 2014; Eckelmann et al. 2014; Strachan et al. 2014), implying persistence of that ocean into the Late Devonian or even Early Carboniferous. If, however, the Rheno-Hercynian Belt had evolved from the Rheic Ocean, it should contain an important volume of inverted Cambrian and Ordovician sedimentary and magmatic rocks relating to the rift phase of the Rheic. Instead, more than 90% of the Rheinisches Schiefergebirge (and probably also equivalent parts of the Rheno-Hercynian Belt) consist of Devonian passive margin sediments, while Cambrian and Ordovician rocks are very subordinate. As laid out in the first paragraph of the present paper, this apparent contradiction is resolved by the observation that the Rheic Ocean was closed already in Early Devonian time and that the Rheno-Hercynian Belt was formed during the closure of the younger, narrow Rheno-Hercynian Ocean.

It remains to explain the fate of the Rheic remnants in more detail. Franke and Oncken (1995) have suggested northward subduction of the Rheic Ocean which affected the onset of Rheno-Hercynian extension by back-arc rifting. Franke (2000, 2006) proposed subduction of the Rheic Ocean also towards the south under the Armorican Terrane Assemblage, eventually leading to ridge subduction which opened the Rheno-Hercynian, Baja California-type successor ocean (see also the discussion of metabasalt geochemistry in Floyd 1995). Since the sedimentary prism at a passive plate margin is usually destroyed when that margin is transformed into an active one, bipolar subduction would help to explain why the sedimentary record of the Rheic Ocean is so scant all along the Rheic suture. In addition, opening of the Rheno-Hercynian Ocean (grossly, but not precisely along the Rheic suture) will have prevented a hard and prolonged collision of Laurentia with peri-Gondwana and also have effected extensional thinning of the Rheic collision zone. This explains why the volume of early Palaeozoic deposits (already decimated by bipolar Rheic subduction) was further reduced to almost nil by Variscan subduction or underplating.

In equivalent parts of the Variscides briefly discussed above, there is so far no evidence of two separate Wilson cycles, either because Rheno-Hercynian sea-floor spreading has exactly retraced the Rheic suture, or because Rheic remnants have been completely destroyed during the Rheno-Hercynian cycle. However, the presence of Late Devonian shelf sediments under the South Portuguese foreland basin and the probable recycling of Baltica-derived Devonian clastic sediments from the Pulo do Lobo unit into that foreland add to the many similarities between the Rheno-Hercynian outcrops in Germany and south-west Iberia (see above). These common features suggest that the Devonian in the South Portuguese Zone, like in Germany, is not the younger part of a continuous Ordovician through to Early Carboniferous sequence, but overlies an Avalonia/Meguma-type basement and represents a separate (Rheno-Hercynian) Wilson Cycle (see also Azor et al. 2008).

"One-ocean models" identifying the Rheic as the only Variscan ocean (e.g. Martínez Catalán 2011; Eckelmann et al. 2014) partly positioned outside the Rheno-Hercynian Belt (Kroner and Romer 2013) will be discussed in a separate paper.

Conclusions

- ICP laser ablation dating of zircon from Namurian C through to Westphalian D sandstones in the foreland basin of the Rheno-Hercynian Belt has revealed, besides Variscan sources, an admixture of Baltica-derived grains. Since the basin was only fed from the south, these findings confirm a model of accretion and recycling of Baltica-derived Devonian shelf sandstones at the Rheno-Hercynian active margin.
- The recycling model is also supported by the composition of the synorogenic clastic sediments which, from the late Viséan onwards, record an increase in the quartz/feldspar ratio and predominance of (meta-)sandstone over granitoid and gneiss clasts.
- Outcrop patterns and metamorphic ages in the southern Rheinisches Schiefergebirge suggest that the recycled sedimentary rocks were first accreted to the base of the orogenic wedge and later exhumed after metamorphism and deformation up to amphibolite grade.
- Major parts of the coal-bearing Late Carboniferous clastic sediments consist of recycled older clastic sediments. A gross mass balance reveals that the recycled sediment volume translates into a palinspastic width well in excess of 100 km, which has to be added to the Rheno-Hercynian passive margin.
- Recycling of Baltica/Laurentia-derived zircons from Devonian clastic sediments into the Carboniferous foreland is also plausible for the South Portuguese Zone (SPZ), which adds to the numerous similarities between the SW-Iberian and German segments of the Rheno-Hercynian Belt and suggests that the sedimentary and volcanic rocks of the SPZ represent the Rheno-Hercynian (and not the Rheic) Wilson cycle.

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