# The basal tectonic mélange of the Cabo Ortegal Complex (NW Spain): Rock assemblages, involved terranes and paleogeographic scenario for the suture of Pangea

**Arenas, R.[1], Sánchez Martínez, S.[1], Castiñeiras, P.[1], Fernández-Suárez, J.[1], Díez Fernández, R.[2], Jeffries, T.E.[3]**

1- Departamento de Petrología y Geoquímica e Instituto de Geología Económica (CSIC). Universidad Complutense. 28040 Madrid, Spain.
2- Departamento de Geología. Universidad de Salamanca. 37008 Salamanca, Spain.
3- Department of Mineralogy. The Natural History Museum. Cromwell Road. London SW7 5BD UK

The Variscan suture preserved in the NW Iberian Massif is included in several allochthonous complexes which are remnants of a gigantic pile of exotic terranes with different origin and tectonothermal evolution. The Cabo Ortegal Complex, with members of most of the exotic terranes described in NW Iberia, is located in the most external position; i.e. it represents the leading edge of the advancing allochthonous pile during its translation from more internal to more external parts of the orogen (from west to east in present coordinates). Recent field work and mapping in the lower units of the Cabo Ortegal Complex provided new data about the tectonic mélange that appears in the lowest structural position: the Somozas Mélange. This mélange unit averages 500 m in thickness and is located in the eastern part of the complex, representing a huge mixing unit located at the advancing front of the allochthonous complexes. The mélange contains metric to hectometric lens-shaped tectonic blocks and slices of metaigneous and metasedimentary rocks wrapped around by a low-T, highly sheared matrix of serpentinites or phyllites. It represents a tectonic imbricate located in the contact area between two of the terranes involved in the allochthonous pile: the basal units, interpreted as the edge of the Gondwana continent subducted below Laurussia at the onset of the Variscan deformation, and the Schistose Domain of Galicia-Trás-os-Montes, considered as a more internal part of the Gondwanan margin. Three rock groups are involved in the mélange: 1) a rock ensemble formed by igneous rocks affected by low to medium-T metamorphism, weakly deformed and mixed with serpentinites forming a typical ophiolitic mélange; 2) a metasedimentary group with phyllites and phyllonites, with scarce conglomerates, marbles and quartzites; 3) high-T metamorphic rocks with varied types of amphibolites and orthogneisses.

The ophiolitic mélange is constituted by submarine metavolcanic rocks (pillow-lavas, submarine breccias, pillow-breccias, hyaloclastites), diabases, gabbros, micro-gabbros, diorites, granitoids and highly serpentinized spinel-bearing ultramafic rocks. The serpentinites are the most abundant rock type in the ophiolitic mélange. The regional metamorphism ranges between greenchist and amphibolite facies and it was probably developed during a high-P gradient. Two granitic rocks included in the ophiolitic mélange were dated using U-Pb geochronology. A granitoid sample taken from a hectometric tectonic block yielded an age of 527 ± 5 Ma. Another granitic rock in other hectometric tectonic block also including gabbros and diorites has been dated at 503 ± 5 Ma. According to their chemical characteristics two different groups of igneous rocks can be distinguished. A first group is formed by gabbros, diorites, granitoids and basalts-basaltic andesites with calc-alkaline affinities and close similarity with igneous suites generated in volcanic arcs. The second group is constituted by diabasic dikes and common basaltic rocks with chemical compositions typical of island-arc tholeiites generated in supra-subduction zone settings. Using field data and in particular the intrusive relationships between both types of igneous rocks, it is possible to interpret that the island-arc tholeiites are younger than the calc-alkaline igneous rocks, and they were probably

generated after a mature volcanic arc located in the periphery of Gondwana, even possibly in its most external margin. In the metasedimentary group, a conglomerate from a large tectonic block included in serpentinites yielded age groups suggesting that its sedimentation occurred in the periphery of the West-Africa Craton. This conglomerate exhibits an age group with a large number of zircons (19 zircons) with ages ranging 630-497 Ma, probably representing the chronology of the Pan-African event and also the activity in the volcanic arc where the other igneous lithologies involved in the mélange were generated. The maximun age of sedimentation of this conglomerate is given by the two youngest concordant zircons, and has been calculated in 465 ± 5 Ma. This age can be considered as a reference age for the end of the magmatic activity in such volcanic-arc located in the periphery of Gondwana. In relation to the rocks group constituted by high-T orthogneisses and amphibolites, an orthogneiss has been dated yielding a U-Pb age of 485 ± 6 Ma, which is interpreted as the crystallisation age of the igneous protolith. This age is similar to other ages of igneous rocks in the basal allochthonous terrane from NW Iberia. The three rock ensembles forming part of the Somozas Mélange can be linked to a common evolution that took place in the periphery of Gondwana. The evolution from a calc-alkaline magmatism typical of mature arcs to a younger one which shows affinities with island-arc tholeiites, can be related to the opening of an intra-arc basin. The progressive widening of this basin could explain the rifting of the external part of the arc, and its subsequent drift leaving behind a new oceanic domain, the Rheic Ocean. According to the materials involved in the Somozas Mélange, which were originally located in the periphery of the Gondwanan edge, the birth date of this ocean can be constrained to a relatively narrow period. This is the time period ranging from the peak activity in a mature volcanic arc (ca. 527-503 Ma) to the development of a basin which includes detritus derived from rocks representing the final magmatic activity in the arc (ca. 465 Ma).

Tectonic mélanges including high-P rocks have been classically related to subduction in collisional scenarios. The mechanisms of mélange formation allow us to interpret the tectonic blocks included as remnants of the terrains involved in it, and can be used to constrain the locus of their development if a palinspastic restoration of the terrains implied in the collision is made. The allochthonous complexes of NW Iberia define a retrodeformable tectonic pile emplaced over Gondwana, constituted by terrains that preserve from bottom to top the evolving palaeogeographic scenario. The lack of huge recumbent folds affecting the whole allochthonous pile suggest that the vertical superposition of units reflects an horizontal distribution of geodynamic and palaeogeographic realms. The inclusion in the mélange of tectonic blocks belonging to the subduction zone generated between the basal and the ophiolitic units (high-T tectonic blocks), suggests that its formation is later in time and that those blocks could be incorporated after exhumation and thrusting of high-P and high-T rocks, that would have operated as the upper block during the mélange formation. As it also includes slices coming from a mature arc, not preserved with similar lithologies in other allochthonous units of NW Spain, and other tectonic slices clearly similar to the Schistose Domain, its place of development could be located between this previous subduction zone and the Schistose Domain. Those facts suggest the existence of two different subduction zones generated in the first stages of the Variscan collision. The first formed by the burial under Laurussia of a continental block attached to the Gondwana margin, recognizable as the most external Gondwana margin in many places of the orogen. The second subduction zone was a new one generated closer to Gondwana, probably during the closure of a restricted back-arc basin located between the cited continental block and Gondwana, that produced a wide tectonization of the rocks between them and the burial of the back-arc series (the Schistose

Domain) and remnants of the mature arc (calc-alkaline and tholeiitic igneous rocks involved in the mélange) below a layer of exhumed basal units.