Late Carboniferous-early Permian tectono-sedimentary cycles and climate proxies in the Pyrenean and Basque-Cantabrian basins, N Spain.

José F. Barrenechea$^{1,2}$, Joan Lloret$^{3,5}$, Raúl de la Horra$^{3}$, Nicola Gretter$^{4}$, Violeta Borruel-Abadía$^{1}$, Ausonio Ronchi$^{5}$, José López-Gómez$^{1}$, Manuel Junca$^{6}$, and José Bienvenido Díez$^{6}$

$^{1}$Instituto de Geociencias (UCM-CSIC), Geomateriales, Madrid, Spain (barrene@ucm.es)
$^{2}$Departamento de Mineralogía y Petrología, Facultad de Geología, Universidad Complutense de Madrid, Spain
$^{3}$Departamento de Geodinámica, Estratigrafía y Paleontología, Facultad de Geología, Universidad Complutense de Madrid, C/José Antonio Novais 12, 28040 Madrid, Spain
$^{4}$Liceo “A. Rosmini”, Corso Bettini, 86, 38068 Rovereto, Italy
$^{5}$Department of Earth and Environmental Sciences, University of Pavia, Via Ferrata 1, 27100 Pavia, Italy
$^{6}$Departamento de Xeociencias Mariñas e O.T. Facultade de Ciencias do Mar, Universidade de Vigo. Campus Lagoas-Marcosende, 36310 Vigo, Spain

The late Carboniferous to early Permian interval was a time of major global changes on Earth. It encompassed the final consolidation of the Pangaea supercontinent and the subsequent development and infill of continental basins. This interval also witnessed a climate transition towards warmer conditions, including the substantial retreat of the extensive continental ice sheets developed during the Late Palaeozoic Ice Age (LPIA). The end of this climate transition represented an evolution from an icehouse to a greenhouse period at the early to middle Cisuralian, which in turn was a time of important tectonic changes in Pangaea. However, our understanding of this whole chain of processes still has many gaps and many of its features still generate debate, especially those concerning the origin and the end of this transition period. This study focuses the late Carboniferous to early Permian interval by means of a multidisciplinary study in the Pyrenean (P) and Basque-Cantabrian (BC) basins, that constitute a near equatorial complex extensional structure located in the middle of the late-Variscan fold belt. The present-day Pyrenean Ranges, extending E-W along almost 1000 Km, from the Mediterranean coast to the Basque-Cantabrian Cordillera, is the result of intense inversion of previous Permian to Cretaceous extensional to transtensional rift basins. In those basins, the time-interval has been traditionally studied in two separated structural units: Basque-Cantabrian Pyrenees and Aragonese-Catalan Pyrenees. However, this multidisciplinary study, proposes the existence of a lateral tectono-sedimentary connection for the entire basin. Nine late Carboniferous - early Permian sub-basins have been studied in the Basque-Cantabrian and Pyrenean domain. From west to east they are: Frieres, Sotres, Carmona, Anayet, Aragorn-Bearn, Castejón-Sas, Erill Castell, Gramós and Camprodón. Three lithological units, separated by unconformities and dated by means of pollen associations and radiometric data, represent the Permian record of these basins. They constitute three cycles of sedimentation of similar age (Gzhelian-Asselian, Asselian-Sakmarian, and
Sakmarian-Kungurian) related to the same post-Variscan geodynamic stages of evolution affecting the whole Pyrenean and Basque-Cantabrian basins. The two younger cycles broadly coincide with other similar cycles defined in SE France and Sardinia, thus pointing to a common tectono-sedimentary evolution for the westernmost continental Peri-Tethys domain during this time-interval. In addition, the middle cycle (Asselian-Sakmarian) mostly represents a calc-alkaline volcano-sedimentary event in most of the sub-basins, related to a post-Variscan extensional phase. Detailed studies of paleosols, sedimentology, and mineralogy indicate a progressive evolution towards warmer conditions that were accelerated during the Artinskian, probably related to the end of the global icehouse period associated to the LPIA in the equatorial late-Variscan fold belt domain.