Geophysical Research Abstracts
Vol. 19, EGU2017-15581, 2017
EGU General Assembly 2017

Analogue models of progressive arcs: insights into the kinematics of Mediterranean orogens as view from the Gibraltar Arc System (GAS)

Alejandro Jiménez-Bonilla (1), Ana Crespo (2), Juan Carlos Balanyá (1), Inmaculada Expósito (1), and Manuel Díaz-Azpiroz (1)

(1) Pablo de Olavide, Sistemas Físicos, Químicos y Naturales, Seville, Spain (alex_jb16@hotmail.com), (2) University of Granada-CSIC, Departamento de Geodinámica-IACT, Campus Fuentenueva, C/ Severo Ochoa, s/n, 18071 Granada, España

The western Mediterranean orogenic belt is characterized by two arcs marked by their extremely tight trend-line pattern. Both arcs, Gibraltar and Calabria arcs, show a similar kinematic pattern of extension in their internal zones associated with the development of a back-arc basin approximately counterweighted by outward radial thrusting in their external zones. At the same time, opposite vertical-axis rotations at the arc limbs have been reported. Our case study is the Gibraltar Arc System (GAS), a highly protruded arc in which differential vertical-axis rotations of hundreds of kilometer-scale blocks have been identified. During the last 10 Ma, these differential rotations reach 70º in the westernmost part of the arc [1]. Consequently, the GAS external zone was deformed into a curved fold-and-thrust belt.

To look into the geometry, kinematics and progressive deformation of the GAS fold-and-thrust belt –which is detached within an evaporitic-rich layer–, analogue models were performed employing a deformable plastic strip that is able to increase its protrusion grade during the experiment. Three types of set-ups were made using: (1) a 66cm x 51cm initial parallelepiped built only with a sand layer; (2) a 66cm x 51cm initial parallelepiped floored by ductile layer of silicone of variable thickness overlaid by sand; (3) a 100cm x 65cm initial parallelepiped floored by silicone overlaid by sand. In all the experiments, the parallelepiped was deformed into a curved fold-and-thrust belt with outward radial transport direction. The thicker the silicone layer is, the more frequent backthrusting is and the more noticeable the lack of cylindrism is. During the progression of the deformation, the arc-parallel lengthening was achieved by arc-perpendicular normal faults and oblique, conjugate strike-slip faults, which individualized blocks that rotated independently in the second and third set of models. Grid markers rotated clockwise and anticlockwise at the left and right limbs of the apex, respectively, ca. 25º in the first set, between 25º and 40º in the second and more than 70º in the third one.

These results differ from previous analogue experiments that used a rigid backstop with different shapes and a straight motion (e.g. [2]), in which it was impossible to generate highly divergent tectonic transport around the indenter. The models we present are the first analogue models of progressive arcs with an indenter that deforms in map view during the experiment progresses. The model results permit us to test the influence of such type of indenter on the shaping of Mediterranean arcs, such as the Gibraltar Arc System external wedge, and in general, of other progressive arcs on Earth, in terms of kinematics, geometry, size of the individualized blocks and rotation of passive markers.

[1] Crespo-Blanc A., Comas, M., Balanyá J.C. (2016) Clues for a Tortonian reconstruction of the Gibraltar Arc: Structural pattern, deformation diachronism and block rotations. Tectonophysics, 2016, 683, 308-324.
[2] Crespo-Blanc A., González-Sánchez, A., 2005. Influence of indenter geometry on arcuate fold-and-thrust wedge: preliminary results of analogue modelling, Geogaceta 37, 11-14.

Acknowledgements: RNM-415, CGL-2013-46368-P and EST1/00231.