Fracture evolution in oil-producing sills of the Rio Grande Valley, northern Neuquén Basin, Argentina

Jan Witte, Massimo Bonora, Carlos Carbone, and Onno Oncken

ABSTRACT

Oil-producing sills are commonly considered atypical reservoirs, although they can hold significant exploration potential. The need for a better understanding of fracture properties and petroleum system characteristics for this and similar igneous rock plays is the main motivation of our study. We explore the evolution of this play type by an analysis of the Los Cavaos oil field, located in the Malargue fold belt of the Neuquén Basin, Argentina, integrating multiscale fracture data from outcrops and subsurface.

The field was created by a combination of intrusions and mild Miocene-Pliocene inversion. Production stems from thick cavity zones in naturally fractured andesitic sills emplaced inUpper Jurassic shale source rocks. Orientation patterns, fracture spacing, and length of fracture sets in the sill are consistent over several orders of magnitude. Large multiply connected and weakly cemented fractures are responsible for excellent interconnectedness in the reservoir. Fracture density is correlated with fault proximity, indicating a cogenetic evolution during active deformation.

Abundant fractures in core with strike-slip to oblique striations support transpressional overprint during and after fracture formation. Although it is challenging to separate cooling from tectonic fractures, we propose two phases of fracturing, marked by a coexistence of subvertical and oblique fractures together with transpressional striae. Petrographic evidence suggests initial local oil expulsion and migration through microfractures, with opening displacements of 0.01 to 1 mm, followed by subsequent charging of the evolving intrasill cavity system as well as the bulk fracture system during cooling and mild deformation. We suggest that the observed patterns may be extrapolated to sills in similar geotectonic settings.