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Mesozoic evolution of the Amu Darya basin

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This study, granted by the Darius Programme, aims at proposing a model of tectono-stratigraphic evolution of the Amu Darya basin since the Late Palaeozoic and to understand the relationship with the nearby basins. The Amu Darya basin, as its close eastern neighbour, the Afghan-Tajik basin, lies on the Turan platform, after the closure of the Turkestan Ocean during the Late Paleozoic. These two basins, spread on mainly lowlands of Turkmenistan, southwest Uzbekistan, Tajikistan, and northern Afghanistan, are separated from one another by the South-Western Gissar meganticline, where series of the northern Amu Darya margin are outcropping.

The evolution is closely controlled by several periods of crustal thinning (post-collision rifting and back-arc extension), with some marine incursions, coming in between accretions of continental blocks and collisions that succeeded from the Late Triassic-Early Jurassic (Eo-Cimmerian orogeny) to the Cenozoic times. These orogenies controlled the deposition of thick clastics sequences, and the collision of the Indian Plate with Eurasia strongly deformed the sedimentary cover of the Afghan-Tajik basin.

The more than 7 km thick Meso-Cenozoic sedimentary succession of the Amu Darya basin, lies on a complex system of rifts and blocks. Their orientation and age (late Permian, Triassic?) are not well known because of deep burial. The north-eastern margin, with the Bukhara (upper margin) and Chardzhou steps, is NW oriented, parallel to the Paleozoic Turkestan suture. The orientation bends to W-E, in the part of the Gissar situated to the North of the Afghan-Tajik basin. This EW trending orientation prevails also in the south(-eastern) margin of the basin (series of North Afghanistan highs) and in the Murgab depression, the south-eastern deepest portion of the Amu Darya basin. It is in this area and in the eastern part of the Amu Darya basin that the Jurassic as well as the lower Cretaceous sediments are the thickest. The south-western part of the basin is occupied by the Pre-Kopet Dagh Cenozoic foreland basin NW oriented, possibly underlain by an earlier extensional trough.

The main elements of the sedimentary pile, which can be partly observed in the South-Western Gissar are: Lower to Middle Jurassic continental to paralic clastic rocks; upper Middle to Upper Jurassic marine carbonate then thick Tithonian evaporite rocks, sealing the reservoirs in the Jurassic carbonates; continental Neocomian clastic rocks and red beds, Aptian to Paleogene marine carbonate and clastic rocks.

To reconstruct the geodynamic evolution of the Amu Darya Basin, we analysed the subsidence by backstripping of some wells/pseudo-wells and of three cross-sections with some examples of thermal modelling on the periods of maturation of the potential source rocks.

The crustal thinning events take place in the Permo-Triassic? (depending on the age of the rifts underlying the basin), in Early-Middle Jurassic and during the Early Cretaceous, resulting in increases of the tectonic subsidence rates.