International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2020 Vol. 10(1) January-April, pp. 13-18/Olegovich
Review Article

THE EVOLUTION OF VIEWPPOINTS TO THE RELIEF STRUCTURE OF THE FERGANA BASIN PREMESOZOIC SURFACE

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ABSTRACT
The different views to the Fergana basin pre-Mesozoic relief structure – from the 70-th of the XX century until today– are considered in this article. The relief map, shown at the end of this paper, was created according to the geophysical modelling data, hardwired to the coordinate axises and drilling data and absolutely corresponds to models. This map is the first, in such precise format, for the Fergana basin.

Keywords: *Fergana Basin, Relief Structure*

INTRODUCTION
The Fergana intermountain Basin is one of the oldest oil and gas producing regions of Central Asia. Despite a history of more than a century, there are still many questions regarding its deep geological structure. The study of the surface of the pre-Mesozoic formation is one of them. Studying the features of the morphology of any surface, one can judge the reasons that led to the formation of structures of the observed form and order. Thus, shedding light on the ambiguities in the history of the geological and tectonic evolution of the region.

Over the course of many decades, in the course of geological exploration in the Fergana region, many schemes and maps of the tectonic structure were built (Tal-Virsky, 1982, Abidov *et al.*, 1992, Akramkhodjaev and Saidalieva, 1971, Babadjanov *et al.*, 1986). However, most of them concerned sedimentary cover structures.

Historical Review
One of the most famous map schemes of this kind was a map constructed by a team of authors under the direction of Abidov and Kalomazov in 1992 (Abidov *et al.*, 1992). Built on the roof of the Paleogene sediments, this one very well reflects the basic structural elements of the structure of the Fergana intermountain Basin (Fig. 1), such as the Central Graben, the South Step and the North Step. In addition, transition zones between the steps and the Graben are distinguished, as well as structures of smaller orders.

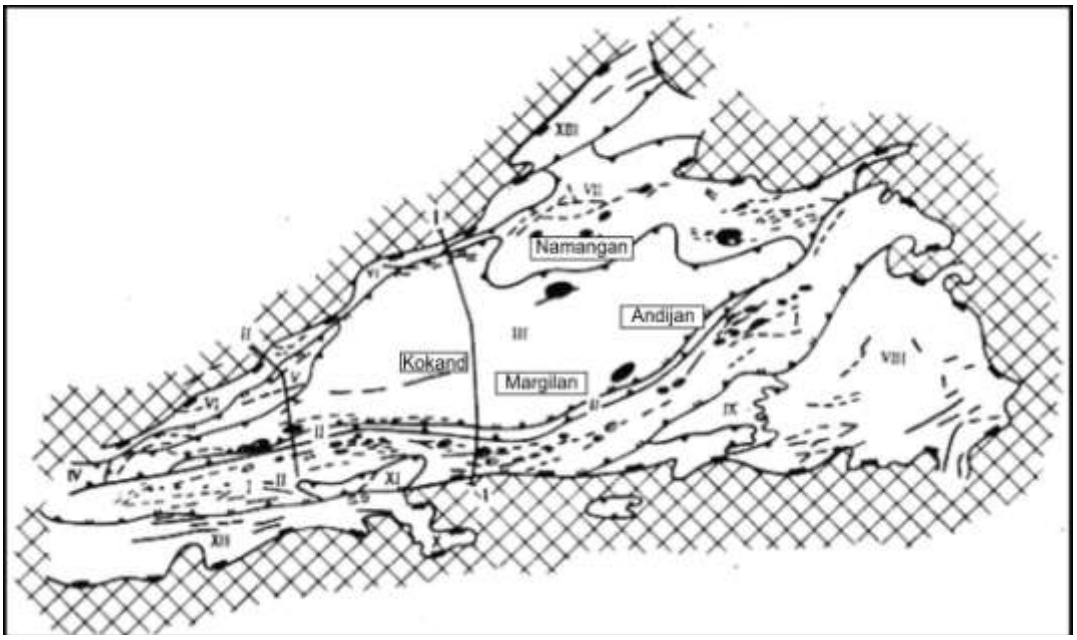

Figure. 1. Scheme of geotectonic zoning of the sedimentary cover of the Fergana intermountain basin (Abidov, *et al.*, 1992).

For deeper surfaces, the most famous is the map of tectonic zoning of the Fergana Basin, developed under the editorship of Tal Virsky (Tal-Virsky, 1982). This map was built in 1970 based on the interpretation of geophysical materials (Fig. 2). Although it was accurate enough for its time, it also had a number of drawbacks - part of the pre-Mesozoic relief was completed by transformation down the section, based on data for the Turkestan layers of the Paleogene. In addition, in this construction, the tectonics and topography of the Central Graben were rather weakly reflected. Nevertheless, for a rather long time, this map was the basis for our ideas about the deep relief of the Fergana Basin. Then, in 2009-2013. Mordvintsev and Mordvintsev studies have been conducted aimed at studying the deep structure of the Fergana Basin (Mordvintsev 2009, 2011, 2012, Mordvintsev and Mordvintsev, 2013).
The first, in 2009, on the basis of a comprehensive interpretation of geological and geophysical information, a relief map of the Pre-Mesozoic surface of the Fergana Basin was constructed at a scale of 1: 500 000 (Fig. 3).

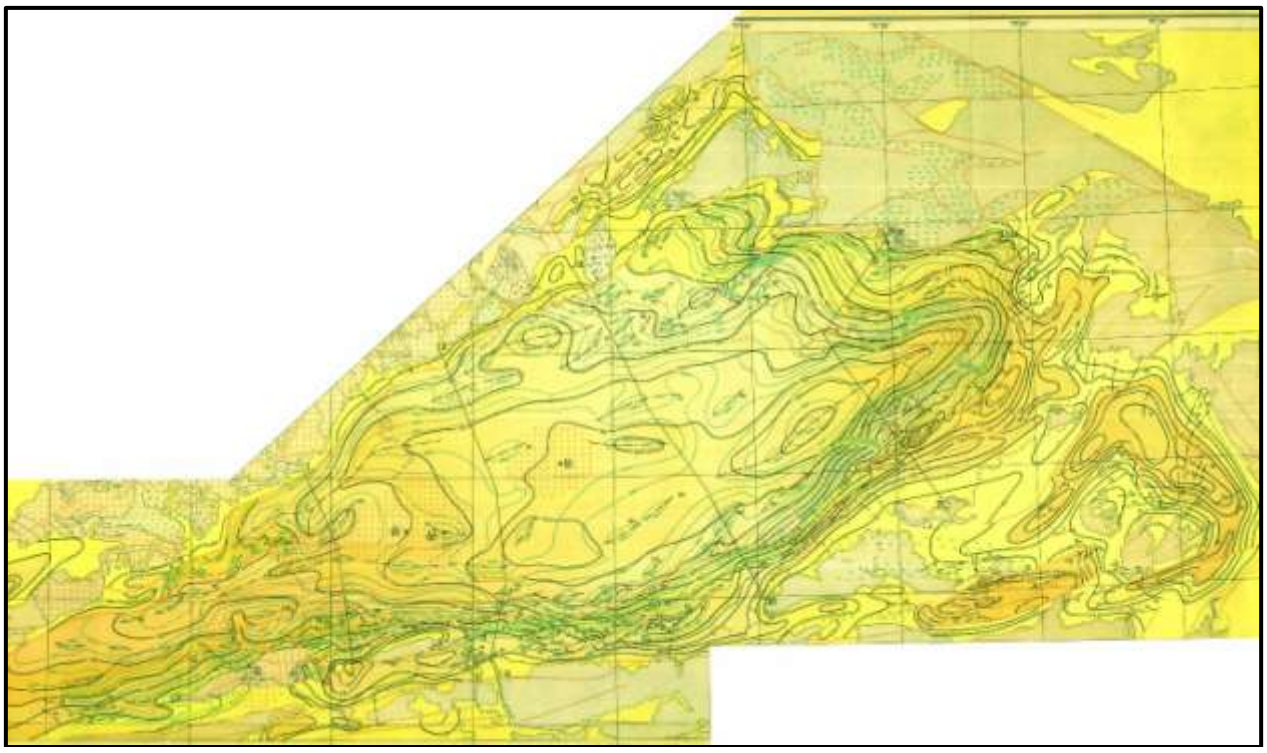

Figure 2: Tectonic map of the Fergana basin (Tal-Virsky, 1982)

The block structure of the pre-Jurassic surface of the North and South sides of the Fergana Basin, as well as the Central Graben, was established. In addition, a developed network of discontinuous violations of various orders was mapped. The most submerged part of the Basin was identified in the east, where a depth of 10 km is recorded.
In 2011, these studies were continued, but on a scale of 1: 200,000 (Mordvintsev, 2011). The geological and geophysical models underlying the constructions have been substantially refined (Fig. 4).
Just as in previous constructions, side zones and the Central Graben clearly stood out here. In addition, a more detailed network of discontinuous faults was also formed, forming the block structure of the surface of the Paleozoic strata of the Fergana Basin.
The most submerged part, as in previous works, fell to the east of the basin, where the depth of the pre-Mesozoic strata was more than 10 km.
On average, over the entire Basin, the surface of the pre-Mesozoic is fixed at depths of 5 to 7 km. The only exception is the airborne zones, where the depth of the pre-Jurassic strata is much lower, up to the outcrops on the day surface.

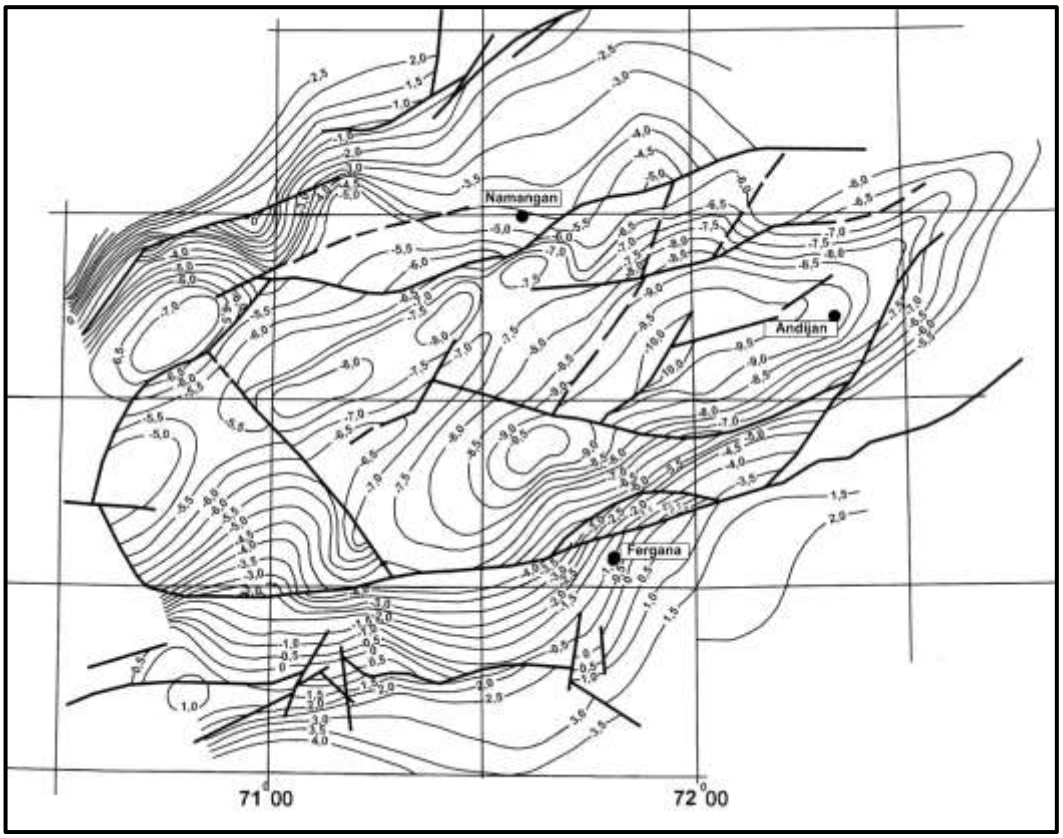

Figure 3: Relief map of the pre-Mesozoic surface of the Fergana basin (Mordvintsev, 2009)

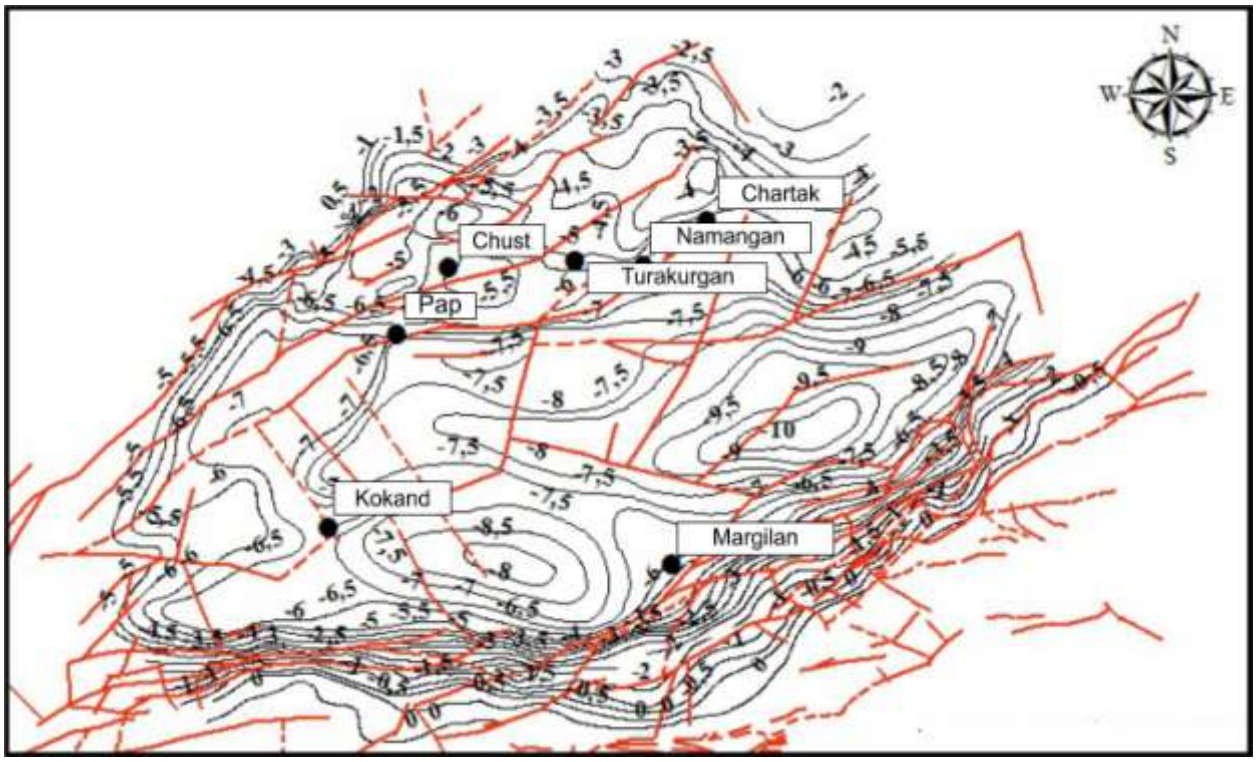

Figure 5: Relief map of the pre-Mesozoic surface of the Fergana basin (Mordvintsev, 2011).

One of the features of the maps presented above was that, despite the rather high accuracy of modeling, they often did not always correspond to the actual well data (where the surface of the Domenozoic was uncovered by the wells), and also sometimes contradicted the models. As a result, it was decided to

continue these studies at a qualitatively new level - with tight binding both to wells and to data obtained as a result of geophysical interpretation.

Modern Viewpoint

The last, at the moment, constructed map (Fig. 6) has a rigid reference on the coordinate grid, and also fully correlates with drilling data (where the thickness of the pre-Mesozoic has been opened by wells). In addition, its main difference from previous constructions is the complete correspondence of the relief to the modeling data. The map is made on a 1: 200000 scale.

In the relief of the Pre-Mesozoic surface, the main structural elements of the Fergana Basin are clearly distinguished: the North and South sides and the Central Graben. There is also a large number of discontinuous violations, for the most part, having a strike, subparallel to the general strike of the cavity.

The south side is a monocline extending from the southwest to the northeast and plunging in the north and northwest direction. Its width in the widest, central part, reaches about 30 km, in general, remaining within 12-15 km.

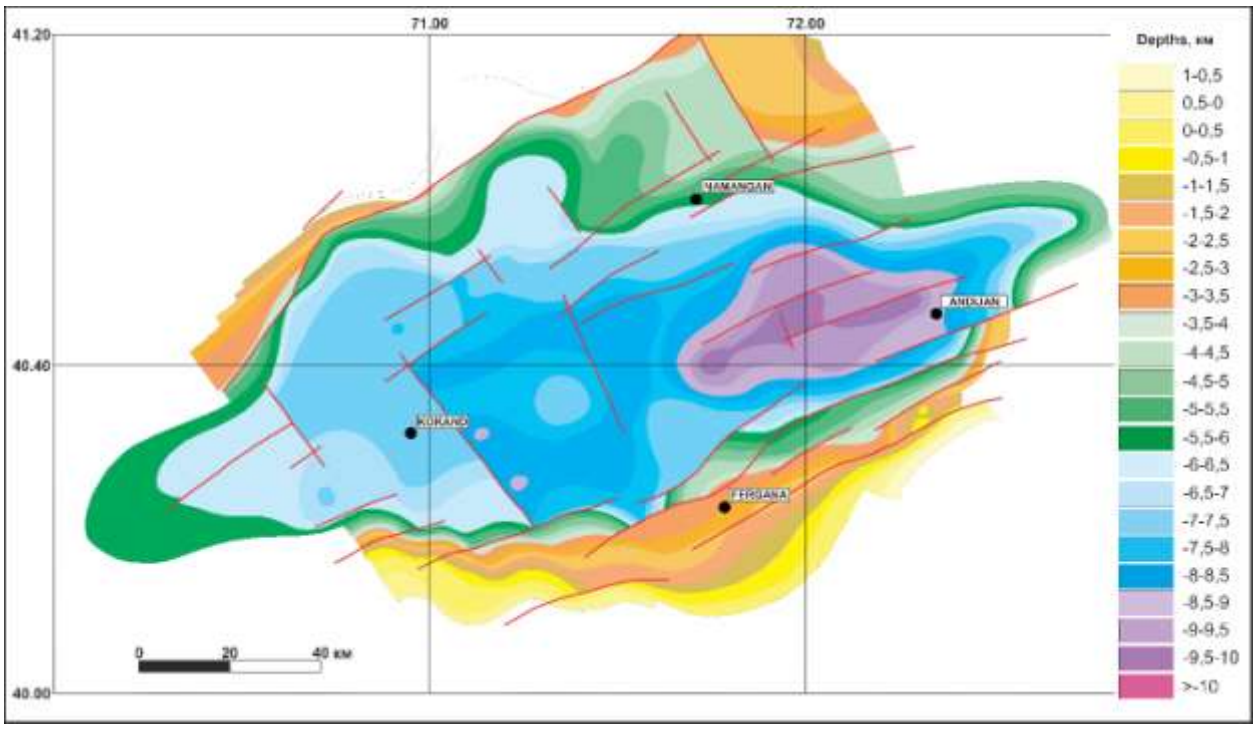

Figure 6: Relief map of the pre-Mesozoic surface of the Fergana basin, (Mordvintsev, 2018)

According to the differences in depths, the South Step can be divided into two large elongated zones.

The first zone, the most southern, is represented by a relatively gentle subsidence of the pre-Mesozoic strata in the north and north-west directions. Depth varies from 0 m (outcrops to the day surface) to 3 - 3.5 km.

The second zone is located to the north and is characterized by a thickening of isolines, especially in the near-fault zone. The depths are 3.5 - 6 km. You can quite confidently say that the dive speed directly

It is connected with the presence of the South Fergana fault here. Moreover, on models on it very often discharges of various amplitudes were recorded.

The central Graben has a fairly calm relief over most of its territory. Nevertheless, its surface can be divided into three relatively large zones.

The first, western, is a fairly gentle deflection towards the center of the basin, with depth differences from 6 to 7.5 km. Its size is approximately 60 to 60 km. East of Kokand, by an extended fault, going across the extension of the Basin, this deflection is separated from the uplift, which can be separated into the second zone. The amplitude of the discharge is about 1 - 1.5 km.

The second zone measures 45 by 60 km. The depth of the pre-Mesozoic surface is from 7 to 8.5 km. From the east, the designated zone is also limited by a discontinuous disturbance going across the extension of the Basin.

Further to the east, there is a strong sinking of the pre-Mesozoic surface to depths of 10 km and more. This deflection has an elongated shape and linear dimensions of the order of 80 by 40 km. In its central part, discontinuous violations that form steps are recorded.

To the north of Namangan, a gently sinking surface of the pre-Mesozoic to the center of the basin is noted. A little to the west, in the relief of the horizon under consideration, there is a structural ledge. Depths range from 3.5 to 6 km.

The northern side is separated from the Central Graben by the North Fergana Fault. Like the South side, it is a monocline, but plunging from north to southeast. The surface of the Pre-Mesozoic complex is noted here at a depth of 1 to 3.5 km.

In contrast to the South Fergana fault, expressed by the zone of several extensive subparallel faults, the North Fergana fault represents one linearly extended fault.

Considering the zone of the South Fergana Fault and the morphology of its surface, it would be more correct to call it not the South Fergana Fault, but the South Fergana flexural-fracture zone.

In general, the relief of the Pre-Mesozoic complex reflects quite well those compression processes that occurred within the Fergana Basin in later eras. According to the geodynamic activity schemes of Central Asia, the main direction of compression is southeast - northwest (Thomas *et al.*, 1999, Coutand *et al.*, 2002, Shayakubov and Dalimov, 1998). In the Pre-Mesozoic relief, this corresponds to the most submerged area in the Central Graben, where the Pamir-Alai massifs seem to “crush” the Paleozoic of Fergana under themselves. This is followed by a raised section. Moreover, it is shifted to the center of the Basin, which is also explained by the fact that the main direction of mass movement is not straight, but in an arc, curved counterclockwise.

This pattern can be observed when compressing a flexible plate. Its edge, on which maximum pressure will be exerted, will bend, the other part will be relatively elevated. And according to the model of regional isostasis (Angevine *et al.*, 1990), the earth’s crust can just be represented in the form of a layer consisting of blocks flexibly interconnected. Where, when applying pressure to one of the blocks, the morphology of the entire formation changes. What we observe on the example of the Fergana Basin.

Thus, the formation of the Paleozoic relief of the Fergana Basin was influenced by the processes of global tectonics - the Indo-European collision.

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