DEPARTMENT OF THE INTERIOR

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Petroleum geology of the Amu-Dar'ya gas-oil province of Soviet Central Asia

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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Abstract

In the Amu-Dar'ya gas-oil province a Mesozoic-Cenozoic sedimentary cover 1-7 km thick rests on folded Paleozoic basement. The structure of the sedimentary cover developed by vertical tectonic movements during Mesozoic and Cenozoic time. Two structural steps, the Bukhara and Chardzhou, are present on the northeast, and a major linear feature, the Repetek arch, extends east-west through the middle of the area. Throughout the rest of the area round to elongate highs are the dominant structural features. An Upper Jurassic Kimmeridgean salt unit extends over most of the area and acts as a seal for gas and oil pools in the underlying reef limestones of Callovian-Oxfordian age. These are the main producers. Where the salt is absent, the pools occur higher in the section in Lower Cretaceous, Albian-Cenomanian, and Paleogene clastic sediments. Other pools are present in the Lower-Middle Jurassic clastic deposits. The province is gas-prone except in the southeast where oil is present also. Deposition of the salt directly on the upper Jurassic carbonate reservoir rocks sealed in early biogenic gas, thus rendering the reservoirs incapable of trapping later oil. The humic composition of the organic matter and subsidence of the source beds into the thermal gas window in the deeper parts of the basin also contributed further to the province being gas-prone.

INTRODUCTION

The Amu-Dar'ya oil-gas province extends over an area of 360,000 km^2 in central and eastern Turkmenia and western Uzbekistan in southern Soviet Central Asia. The southwest border of the province is coincident with the international boundaries with Iran (fig. 1). The province extends southeastward into Afghanistan, covering an additional area of about 45,000 km^2.

The province is part of the Turan platform, a region of epi-Hercynian consolidation overlain by marine and continental Mesozoic and Cenozoic platform deposits 1 to 7 km thick.

Oil exploration began in the region in 1929. The period from 1935 to 1952 was a time of various geological surveys and geophysical work, largely gravity and magnetic surveys.

Exploration was intensified beginning in 1953 after discovery of the Setalantepe gas field, the first in the province. Seismic surveying has been used in ever increasing volume since 1955. Coordinated regional and detailed geological surveys of the entire region began in 1957 after discovery of the Gazli gas field (Aliyev and others, 1983).

The province is gas-prone. In most areas no oil is present; only in the Bukhara area on the east is there significant oil (Semenovich, 1976). Zhabrev (1983) places gas reserves of Central Asia as of 1980 at 121 tcf (3.46 trillion m^3); most of these reserves are in the study area. Production for the Amu-Dar'ya province during 1980 was 3.6 tcf (0.103 trillion m^3), and total for the entire time of production up until the beginning of 1981 has been 37 tcf (1.06 trillion m^3). This gas is supplied to the Urals and the central European part of the U.S.S.R. Older giant fields such as Gazli are approaching depletion, but new giants such as Dauletabad-Donmez have just recently come on stream.

STRUCTURE

Introduction

The Amu-Dar'ya oil-gas province coincides with the eastern half of the Turan platform. A Mesozoic-Cenozoic sedimentary cover 1 to 7 km thick rests on folded Paleozoic basement, which is part of the Hercynide orogenic belt. An upper Jurassic salt unit divides the sedimentary section into sub-salt and supra-salt parts. On the west, this platform extends offshore into the Caspian Sea, and its continuation farther west into the North Caucasus to be part of the Scythian platform is uncertain. On the north, the platform joins with the West Siberian platform to become part of the single epi-Paleozoic Ural-Siberian platform. On the south is the Alpine Kopet Dag foldbelt, and on the east are the Southwest Spurs of the Gissar Mountains, where folding was in the late Tertiary. On the southeast the platform extends far into Afghanistan.

The structure of the sedimentary cover of the Amu-Dar'ya oil-gas province developed by vertical movements during the Mesozoic and Cenozoic (Yanena and

Mamedov, 1982). The Amu-Dar'ya regional low extends over the eastern three-quarters of the province and has an area of 270,000 km^2 (fig. 2). On the west are the Central Kara Kum arch, the Bakhardok flank, and the Cis-Kopet Dag foredeep (1,2, and II of fig. 2). The Amu-Dar'ya regional low is divided in some works by the Repetek-Yerbent basement fault into the Amu-Dar'ya depression on the north and the Murgab depression on the south (Bakirov, 1979).

The structural subdivisions used in this report are taken from Dikenshteyn and others (1973). Their map (fig. 2), however, shows only the outlines of the large structures. More detailed maps from Luppov and others (1972) are referred to in the description of the individual structures. The nomenclature used on these more detailed maps, however, is not everywhere the same as on the Dikenshteyn maps. Such differences are noted in the text.

Structural features

The Central Kara Kum arch (1 in fig. 2) is 250 km long in the north-south direction and 150 km wide in the east-west direction (fig. 3). The surface of the Paleozoic basement in the central part of the arch is at a depth of 1,600 to 2,200 m; on the flanks this surface plunges to 3,000 to 3,500 m. A large number of faults of different orientation and displacement are present at the crest and on the flanks of the arch. In the central part of this structure is the Zeagli-Darvaza domal high within which are several small anticlines.

The Central Kara Kum arch has been described as a "median massif of early consolidation." This suggests that the structure may well be associated with a micro-plate caught up in the Hercynide orogenic belt. The arch is indeed expressed on all crustal layers from the M-discontinuity to the base of the Miocene.

The monoclinal Bakhardok flank (2 in fig. 2) is on the south of the Central Kara Kum arch. It is 500 km long and 50 to 150 km wide. This feature is the border of the platform, transitional to the Cis-Kopet Dag foredeep immediately to its south. Depth to basement is 3 km in the north to 5 km in the south. In this same direction, the depth to the top of the Cretaceous System increases from 0.9 to 2 km (fig. 4).

The Cis-Kopet Dag foredeep (II in fig. 2) extends 550 km in a northwest direction and is 25 to 60 km wide. Depth to the base of the Jurassic rocks in the deepest parts reaches 10 km (fig. 4). On the south, this foredeep is bounded by the Kopet Dag fold belt or mega-anticlinorium (Rogozhin and Borisov, 1984).

The structure of the area between the Central Kara Kum arch and the Zaunguz downwarp is subdivided differently by Luppov and others (1972, p. 530) from that shown in figure 2. The Beurdeshik step and Khiva downwarp to its east (3 and 4 of figure 2) are shown as the Balkuin downwarp, the Kirpichli high, and the Ilim downwarp (II, III, and IV of fig. 5).

The Beurdeshik step (3 in fig. 2) is the northwest monoclinal flank of the Amu-Dar'ya regional low. It is 200 km long and 20 to 50 km wide. Thickness of the sedimentary cover is more or less 3 km.

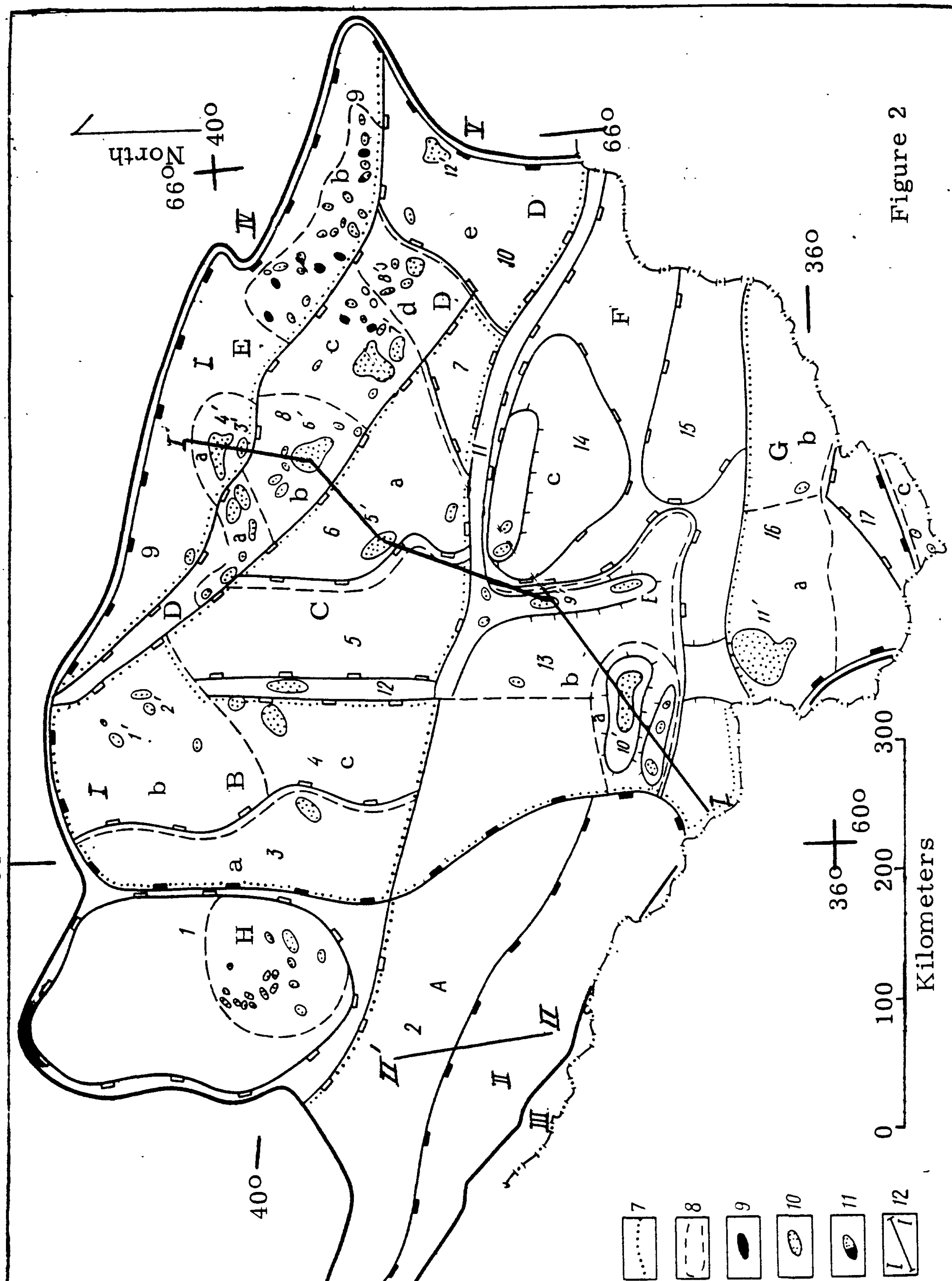


Figure 2

Figure 2.--Amu-Dar'ya oil-gas province (from Dikenshteyn and others, 1973).

Symbols: Boundaries of tectonic elements: 1 - very large, 2 - large, 3 - medium; 4 - not applicable in this figure; 5 - main faults.

Boundaries: 6 - province, 7 - regions, 8 - areas.

Fields: 9 - oil, 10 - gas and gas condensate, 11 - oil-gas and gas-oil, 12 - lines of profile.

Very large tectonic elements: I - Amu-Dar'ya regional low, II - Cis-Kopet Dag foredeep, III - Kopet Dag mega-anticlinorium, IV - Kyzyl Kum ridge, V - Southwest Gissar mega-anticline.

Large tectonic elements: 1 - Central Kara Kum arch, 2 - Bukhardok flank, 3 - Beurdeshik step, 4 - Khiva downwarp, 5 - Zaunguz downwarp, 6 - Malay-Bagadzha saddle, 7 - Karabekaul downwarp, 8 - Chardzhou step, 9 - Bukhara step, 10 - Beshkent downwarp, 11 - Repetek arch, 12 - Vostochno-Unguz zone of highs, 13 - Mary-Serakh zone of highs, 14 - Uchadin arch, 15 - Severo-Karabil downwarp, 16 - Badkhyz-Karabil zone of highs, 17 - Karaimor downwarp.

Oil-gas regions and areas: A - Cis-Kopet Dag prospective oil-gas region: B - Beurdeshik-Khiva gas region, including the following gas areas: a - Beurdeshik, b - Naip, c - Kirpichli; C - Zaunguz oil-gas region including: a - Bagadzha gas area; D - Chardzhou gas-oil region, including the following areas: a - Gugurtli gas, b - Kandym gas, c - Dengizkul gas-oil, d - Kultak gas, and e - Beshkent gas; E - Bukhara gas-oil region, including the following areas: a - Gazli gas, b - Kagan-Mubarek gas-oil; F - Murgab gas region, including the following gas areas: a - Shatlyk, b - Bayram-Aliy, and c - Uchadin; G - Badkhyz-Karabil gas region, including the following gas areas: a - Dauletabad, b - Karabil, c - Kushka; H - Central Kara Kum independent gas region.

Fields: 1'- Achak, 2'- Naip, 3'-Gugurtli, 4'- Gazli, 5'- Bagadzha, 6'- Kandym, 7'-Urtabulak, 8'-Zevarda, 9'-Bayram-Aliy, 10'- Shatlyk, 11'- Dauletabad-Donmez (Sovetabad), 12'- Shurtan.

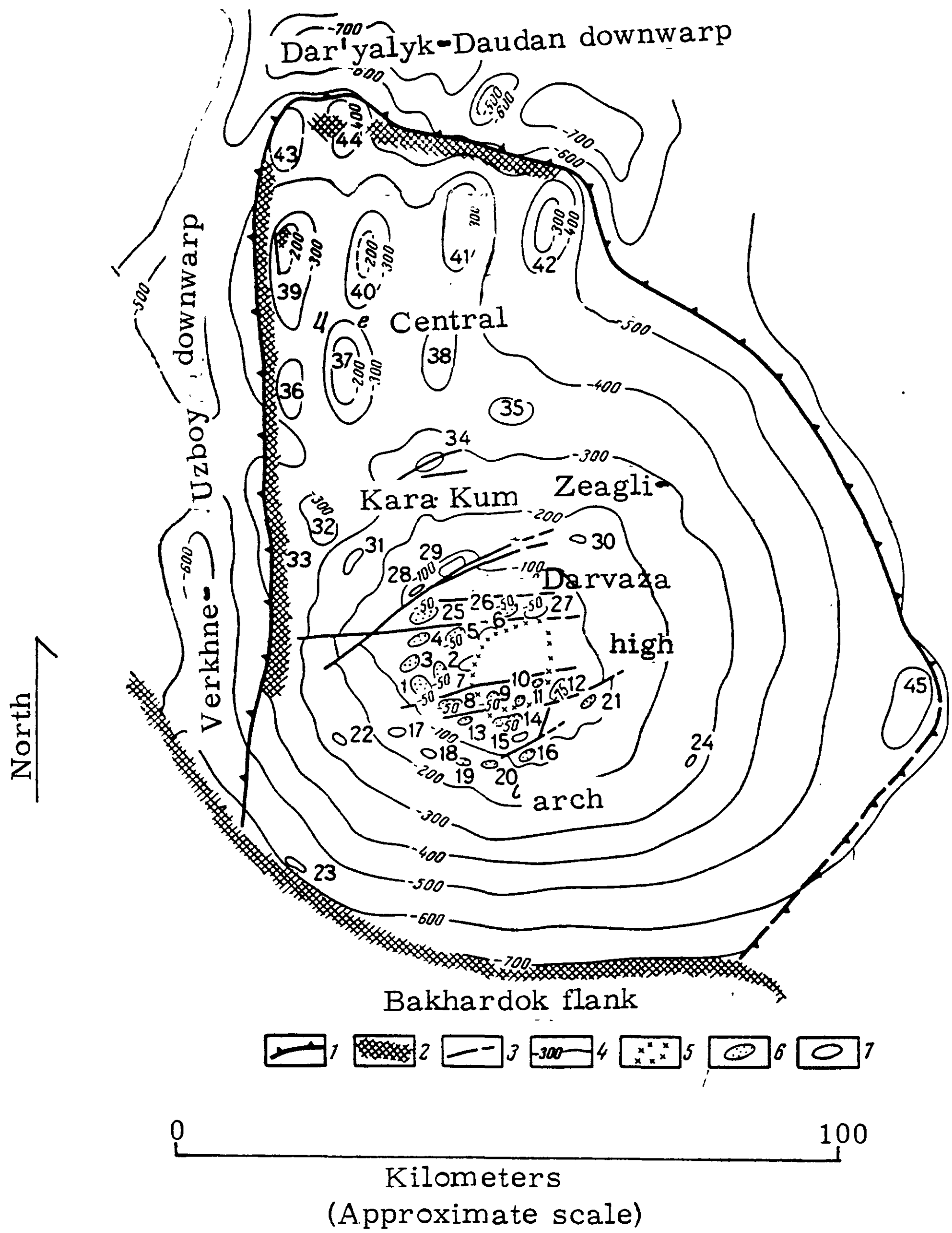


Figure 3.--Structure map of Central Kara Kum arch (from Luppov, 1972). See figure 2 for regional location.
1 - Boundary of arch; 2 - flexure-fault zones along border; 3 - faults; 4 - structure contours on top of Cretaceous sediments; 5 - Sernozavod zone of rupture; 6 - gas fields; 7 - anticlines (Fields are shown in figure 16.)

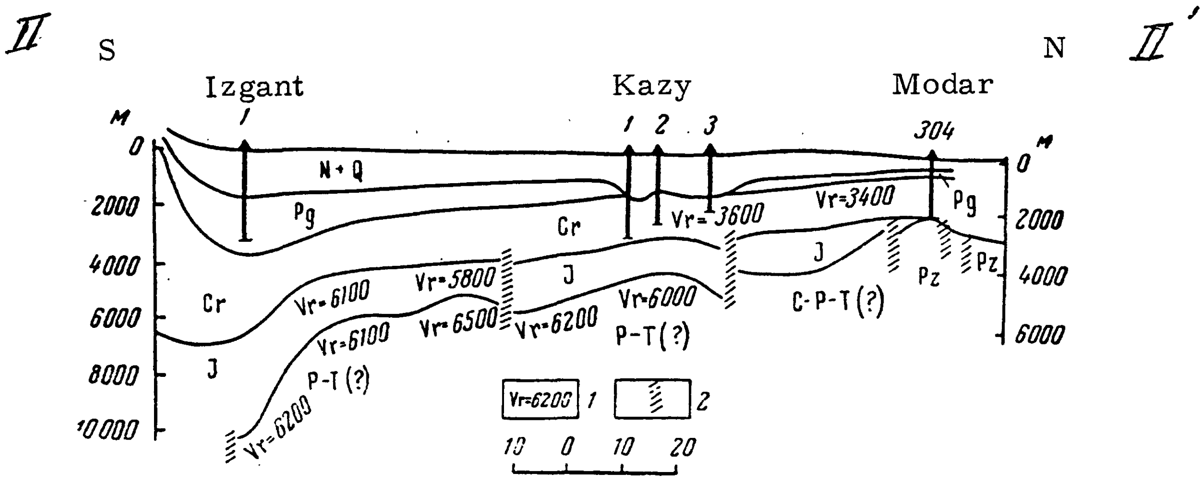


Figure 4.--Section through Cis-Kopet Dag foredeep (on south) and Bukhardok flank (on north) (from Luppov and others, 1972).

1 - Boundary velocity of refracted waves; 2 - deep faults. See figure 2 for location of profile II-II.

The Khiva downwarp (4 in fig. 2) extends north-south 300 km and east-west 100 km. It is bounded on the south by a fault which is a continuation of the Repetek arch (11 on fig. 2). The pre-Jurassic substrat there is a graben filled by more than 3 km of Permo-Triassic sediments, beneath which is the Hercynide basement. The Mesozoic-Cenozoic section is 4,000 to 5,000 m thick.

The Vostochno-Unguz zone of highs (12 in fig. 2 and VII in fig. 5) is about 150 km long and consists of three separate highs along its axis. From north to south they are the Gagarin, Yuzhno-Unguz, and Severo-Chemshin. The Gagarin is the best studied of these; it is expressed on all horizons from the surface of the basement to the Paleogene, inclusively. This structure measures 45 by 15 km and has a closure of 250 to 300 m.

The Zaunguz downwarp (5 in fig. 2 and I in fig. 5) is 220 km long in the north-south direction and 80 to 100 km wide. The interior of the basin is relatively flat structurally. Depth to pre-Jurassic basement is more than 4 km; to the top of the Jurassic, 3,100 m; and to the top of the Cretaceous, 800 to 1,000 m. The northeast border of the downwarp is a steep flexure in the sedimentary cover above the Amu-Dar'ya regional fault (B in fig. 5). The Repetek arch forms the south border. Several anticlinal structures are present within the downwarp (fig. 5).

The area to the east of the Zaunguz downwarp is shown differently by Luppov and others (1972, p. 518) from that used in figure 2. The area of the Malay-Bagadzha saddle (6 of fig. 2), as used in this report, is divided by Luppov and others into Malay high, Bagadzha high, and Deynau downwarp (VIII, IX, and X of fig. 6).

The Malay-Bagadzha saddle (6 in fig. 2) is structurally higher than downwarps on the east and west, and structurally lower than linear zones on the north and south. This saddle has an area of 14,000 km^2. Depth to the pre-Jurassic basement is about 4 km. The large Bagadzha anticline in the west part of the saddle has an area of perhaps one-third of the saddle itself.

The Karabekaul downwarp (7 in fig. 2 and C-IV in fig. 6) extends in a northwest direction immediately south of the Amu-Dar'ya River. It is 180 km long and 20 to 60 km wide. The area has received but little study. Thickness of the sedimentary cover according to seismic surveys reaches 5 to 6 km in the southeast part. The top of the Jurassic is at about 3,400 m, and that of the Cretaceous is at 1,200 to 1,300 m. Several anticlines have been detected, the largest being 30 by 20 km and having a closure of about 100 m.

The Beshkent downwarp (10 in fig. 2) lies between the mountainous Southwest Spurs of the Gissar Range on the east (V of fig. 2) and the Chardzhou step on the west. On the southwest it opens out into the Karabekaul downwarp (C-IV of fig. 6). It measures 150 by 55 km. This downwarp marks the eastern end of the Turan platform. Thickness of the sedimentary cover is 4 to 5 km. Within the downwarp are narrow anticlinal zones of southwest trend.

The Bukhara step (9 in fig. 2) is the northernmost structure of the Amu-Dar'ya regional low and is immediately southwest of the Kyzyl Kum Range,

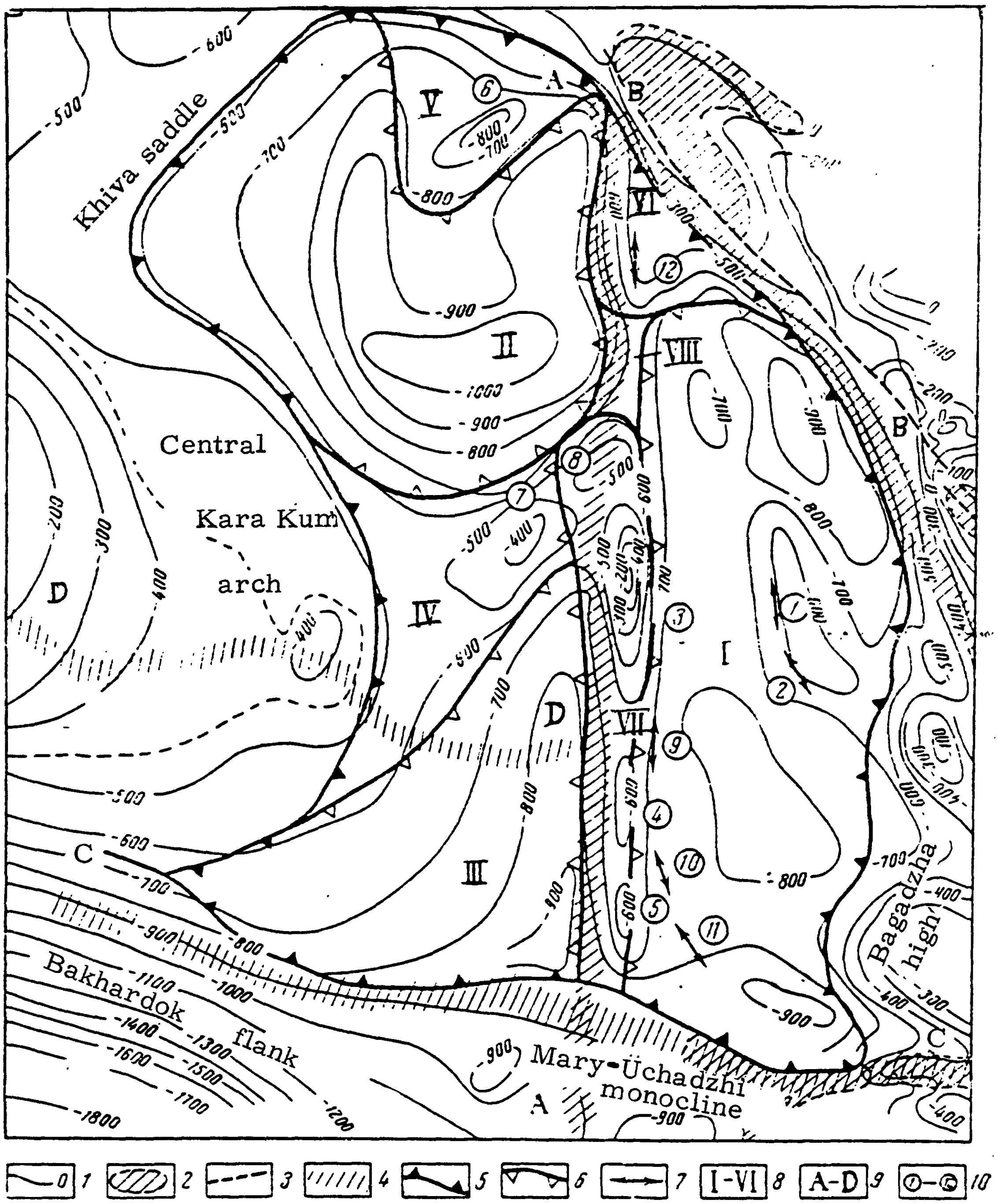


Figure 5.--Tectonic map of Zaunguz depression (from Luppov and others, 1972).

1 - Structure contours on top of Cretaceous sediments; 2 - areas of significant erosion of Cretaceous sediments during Neogene time; 3 - faults in sedimentary cover; 4 - regional faults; 5 - boundary of Zaunguz depression; 6 - boundaries of structures within depression; 7 - axes of anticlines (closure less than 100 m and not expressed by structure contours); 8 - structures within depression: I - Zaunguz downwarp, II - Balkuin downwarp, III - Ilim downwarp, IV - Kirpichli high, V - Urgench high, VI - Zapadno-Pitnyak terrace, VII - Vostochno-Unguz high, VIII - Izmail saddle. 9 - Regional faults: A - Khorezm-Yelan, B - Amu-Dar'ya, C - Repetek-Yerbent, D - Unguz. 10 - Anticlines: 1 - Mergen, 2 - Yuzhno-Mergen, 3 - Gagarin, 4 - Yuzhno-Unguz, 5 - Severo-Cheshmin, 6 - Achak, 7 - Kirpichli, 8 - Balkuin, 9 - Tallin, 10 - Dzhart, 11 - Arap, 12 - Koshkuin.

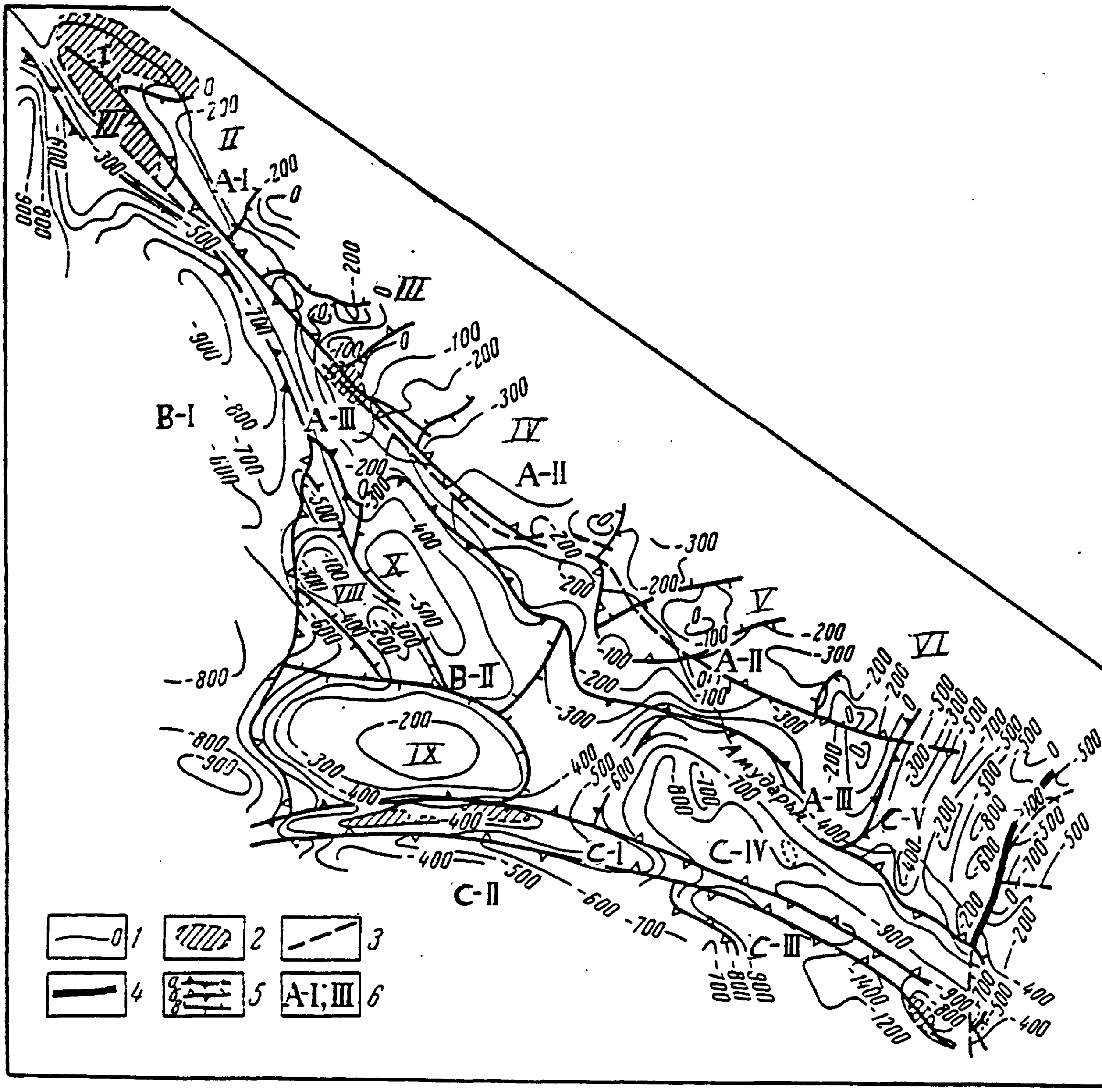


Figure 6.--Tectonic map of central part of Amu-Dar'ya regional low (from Luppov and others, 1972).

1 - Structure contours on top of Cretaceous sediments; 2 - area of significant erosion of Cretaceous sediments during Neogene time; 3 - faults in sedimentary cover; 4 - boundary of Turan platform with Alpine orogenic region; 5 - boundaries of structural elements: a - first order, b - second order, c - third order; 6 - structures: A - Amu-Dar'ya step-monoclinal region: A-I - Bukhara step, A-II - Chardzhou step, A-III - Amu-Dar'ya dislocation; B - Khorezm-Ismail region: B-I - Zaunguz depression, B-II Bagadzha high; C - South Turkmen border zone: C-I - Repetek arch, C-II - Mary-Uchadzhi monocline, C-III - Murgab depression, C-IV - Karabekaul downwarp, C-V - Beshkent downwarp; I - Meshekli high, II - Burgutti downwarp, III - Gugurtli-Uchkyr arch; IV - Chardzhou high; V - Dengizkul arch, VI - Sundukli high, VII - Sultansandzkar arch; VIII - Bagadzha arch, IX - Malay high; X - Deynau downwarp.

from which it is separated by a regional fault. The southwest border of this structural step is also a regional fault. The Bukhara step is 500 km long and 50 to 80 km wide. Depth to basement is 1 to 2 km (fig. 7).

The Bukahra step is characterized by a block structure due to longitudinal and transverse zonality. The longitudinal zonality is a reflection of Hercynian structures and faults of the basement, whereas the transverse zonality is a manifestation of younger, largely Neogene faulting of northeast trend parallel to the structure of the Southwest Spurs of the Gissar Mountains (Bakirov and others, 1979, p. 79).

The Chardzhou step (8 in fig. 2) consists of a belt of block structures bounded on the northeast and southwest by faults. The belt is 500 km long and 40 to 125 km wide. Depth to basement is 2,800 to 4,000 m (fig. 7). Thickness of the Jurassic and Cretaceous section is greater here than on the Bukhara step, and the Upper Jurassic salt extends over the entire area. Just as on the Bukhara step, there are two systems of faults: an older of northwest trend and a younger of northeast trend.

The Repetek arch (11 in fig. 2) is associated with the arcuate Repetek-Yerbent basement fault, which extends westward across the Amu-Dar'ya regional low from Afghanistan. This arch is about 450 km long and not more than 12 to 15 km wide. It is masked on the surface by Quaternary sediments.

Differences in gravity fields on opposite sides of the Repetek-Yerbent fault suggest that this fault separates regions that were already tectonically different in pre-Jurassic time. The surface of the basement within the area of the arch is at depths of 6 to 14 km.

The sub-salt Jurassic sediments form a narrow arch above the Repetek-Yerbent fault; its amplitude is 250 to 300 m, and angles dip are 6 to 7°. The Jurassic salt-bearing Gaurdak Formation on the Repetek arch is hundreds and even thousands of meters thick (Andreyev and Kolchina, 1981). The salt forms numerous plugs, which intrude Cretaceous and also Neogene-Quaternary sediments, locally even reaching the surface (figs. 8 and 9). Some of the plugs are 2,000 to 3,000 m high and more.

A chain of anticlines extends along the Repetek arch, and most have diapiric or cryptodiapiric cores. Intensity of diapirism diminishes from east to west.

To the south of the Repetek arch and corresponding Repetek-Yerbent basement fault are the Mary-Serakh zone of highs (13 in fig. 2) and the Uchadzhi arch (14 in fig. 2). These are combined by Luppov and others (1972) into the Mary-Uchadzhi monoclinal region (fig. 8), and by Zhabrev and others (1983) into the Zakhmet monocline (fig. 20). The southern boundary of this monoclinal region is a fault that separates the region from the Murgab depression on the south. The Murgab depression is not designated as a separate structure by Dikenshteyn and others (1973); however, it is used by numerous other Soviet authors. The Mary-Serakh zone of highs and the Uchadzhi arch are separated from one another by the Murgab regional fault, above which is the Bayram-Ali anticline (figs. 8 and 9).

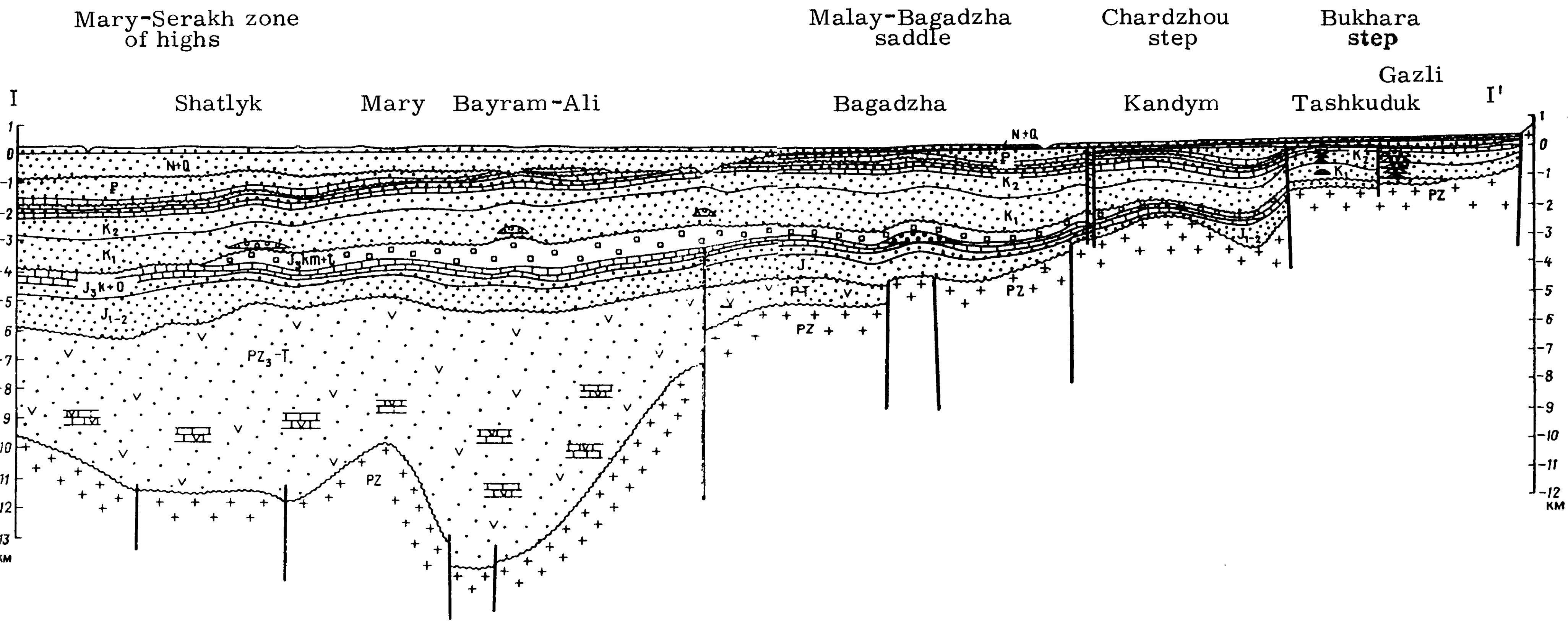


Figure 7. Profile along line I-I′ of fig. 2 (after Bakirov, 1979).
This profile is presented to show structure. The symbols for lithology are not explained in the original Russian text.
PZ - Paleozoic; PZ_3-T - Upper Paleozoic-Triassic; J_{1-2} - Lower-Middle Jurassic; J_3k+o - Upper Jurassic Callovian and Kimmeridagean; K_1 - Lower Creatcaous; K_2 - Upper Cretaceous; P - Paleogene; N+Q - Neogene and Quaternary

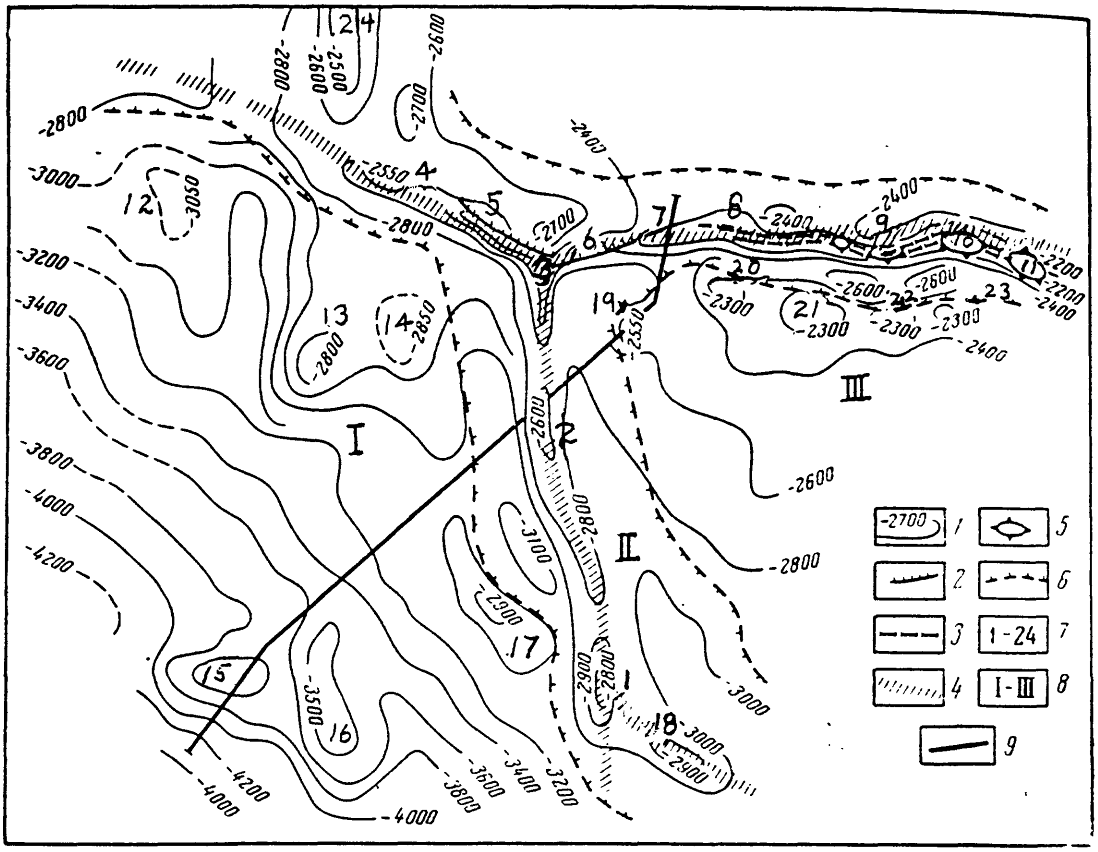


Figure 8.--Tectonic map of Mary-Uchadzhi monocline (from Luppov and others, 1972).

1 - Structure contours on seismic horizon in Upper Jurassic (?); 2 - established faults; 3 - probable faults; 4 - fault zones; 5 - salt domes; 6 - boundaries of zones of fault tectonics; 7 - anticlinal folds; 8 - main tectonic elements: I - Mary high, II - Bayram-Aliy zone of dislocations, III - Uchadzhi high; 9 - line of profile (fig. 9).

Anticlinal folds: 1 - Maysk, 2 - Bayram-Ali, 3 - Severo-Bayram-Ali, 4 - Cheshmin, 5 - Keliy, 6 - Sharaplin, 7 - Zapadno-Utemergen, 8 - Utemergem, 9 - Martov, 10 - Repetek 11 - Yuzhno-Repetek, 12 - Koinkuin, 13 - Yelan, 14 - Vostochno-Yelan, 15 - Dzhudzhuklin, 16 - Shekhitlin, 17 - Mary, 18 - Iolotan, 19 - Tarkhan, 20 - Seyrab, 21 - Uchadzhi, 22 - Vostochno-Uchadzhi, 23 - Peschannyn, 24 - Severo-Chishmin

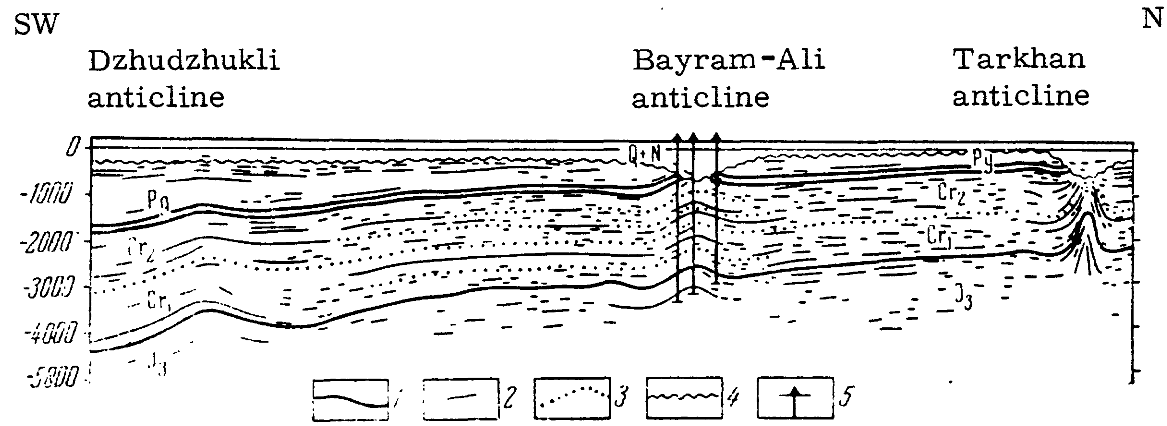


Figure 9.--Seismic section of Mary-Uchadzhi monocline (from Luppov, 1972). See figure 8 for location.

1 - Marker seismic horizons; 2 - seismic horizons; 3 - geologic contacts; 4 - erosion surface; 5 - deep wells.

In the Mary-Serakh zone of highs the base of the Jurassic sediments is at depths of 5 to 6 km. Beneath these are another 4 to 5 km of Upper Paleozoic-Triassic sediments (fig. 7). Gravity and magnetic highs coincident with this zone suggest that it corresponds with an ancient anticlinal structure within the basement. In the southern part of the zone are the large Shatlyk (Dzhedzhukli anticline in fig. 9) and Tedzhen arches, which extend westward into the Cis-Kopet Dag foredeep. The dimensions of this zone are 140 by 80 km.

The Bayram-Ali arch is expressed clearly in the Paleogene, Cretaceous, and Jurassic sediments as a linear high 120 km long in the north-south direction and 24 km wide. Closure is 400 m. The crest undulates, forming from north to south the Severo-Bayram-Ali, Bayram-Ali, and Maysk highs.

The Uchadzhi arch is 210 by 100 km. Depth to folded basement is 7 km on the north next to the Repetek-Yerbent fault. The basement surface dips regionally to the south to a depth of 9 km.

The Severo-Karabil downwarp (15 in fig. 2) is a structural low between the Uchadzhi arch on the north and the Badkhyz-Karabil zone of highs on the south. The base of the Jurassic here is at a depth of 6 to 7 km. The downwarp is 100 to 120 km long and 35 to 50 km wide. It continues westward into the Dauletabad downwarp, which is not designated on figure 2.

The Badkhyz-Karabil zone of highs (16 in fig. 2) is a system of raised basement blocks. Depth to the base of the Jurassic System ranges from 800 to 3,000 m; the greater depths are on the north.

The Kalaimor downwarp (17 in fig. 2) is on the extreme south of the Amu-Dar'ya oil-gas province and extends into Afghanistan.

STRATIGRAPHY

Introduction

The geologic history of the Amu-Dar'ya oil-gas province is known reliably only with the beginning of the Jurassic Period. The pre-Jurassic history is divided into three parts: Precambrian-early Paleozoic, middle Paleozoic, and late Paleozoic-Triassic. These earlier stages are recognized from outcrops along the margins of the province and from geophysical surveys. The time from the Jurassic to the present is divided into two parts: Jurassic-Paleogene and Neogene-Quaternary.

Precambrian-Early Paleozoic stage

Rocks of this age are known only in the extreme eastern part of the study area in the Kugitang region (fig. 10). Sedimentary rocks of probable Proterozoic age were regionally metamorphosed at the end of the Proterozoic or beginning of the Paleozoic (Luppov, 1972, p. 714). Perhaps this was part of the Pan-African event.

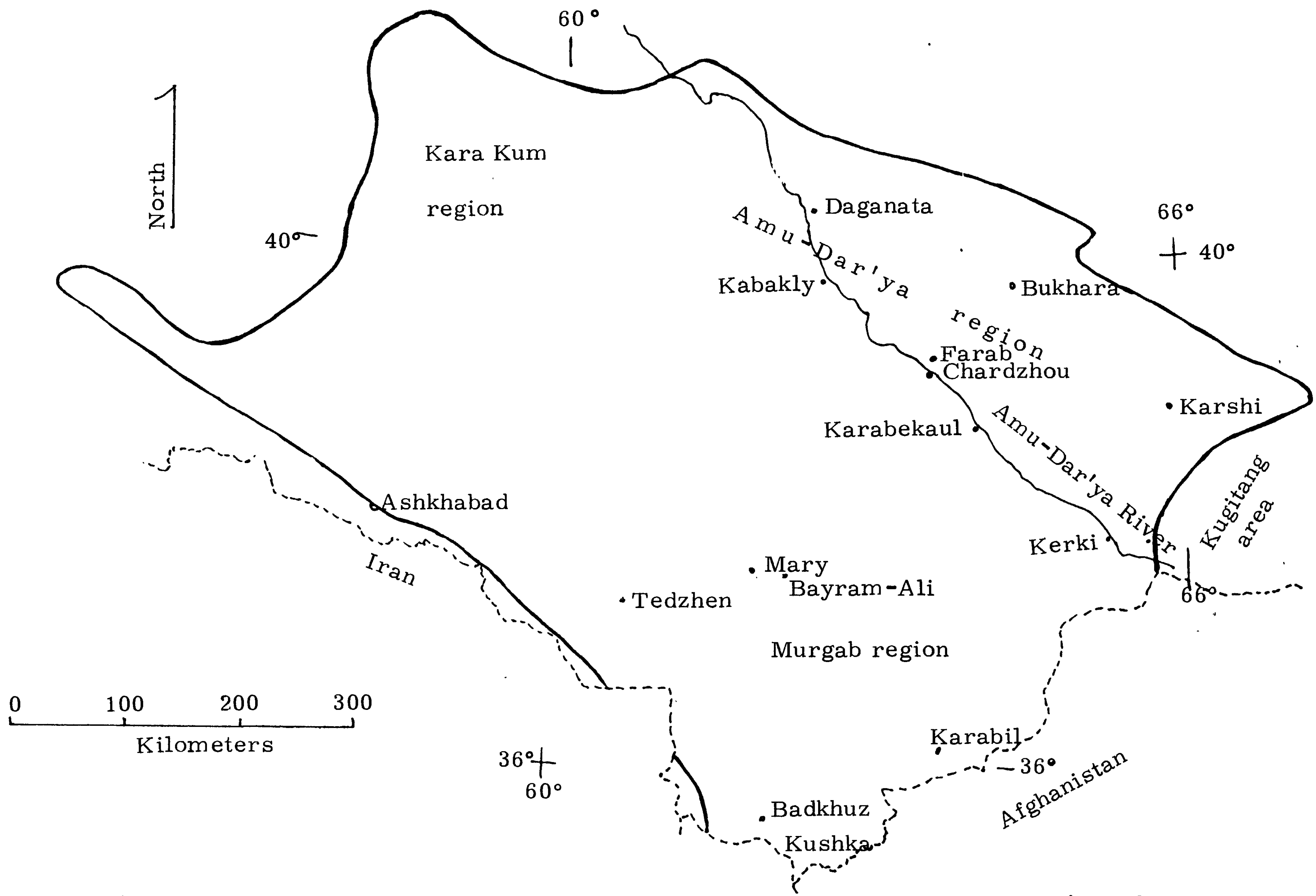


Figure 10. Map showing localities mentioned in stratigraphic description of Amu-Dar'ya oil-gas province.

Middle Paleozoic stage

During the Silurian and Devonian Periods, a geosyncline was present in the region north of the study area. This North Turkmen seaway was part of the Tyan-Shan geosyncline, which extended from China westward through the Caucasus into Central Europe. In the study area itself, however, the marine invasion took place only in the Early Carboniferous, and, after deposition of coarse clastics, carbonates were deposited. Volcanic rocks are also present in the section.

Late Paleozoic-Triassic stage

The geosynclinal conditions of the middle Paleozoic continued into the late Paleozoic as a single great cycle of deposition. The end of the Paleozoic and beginning of the Mesozoic, however, were a time of change from geosynclinal to orogenic conditions accompanied by uplift, erosion, and deposition of molasse. In middle Carboniferous time tectonic movements affected the entire middle Paleozoic geosyncline. This led to complete withdrawal of the sea by the beginning of the Permian Period and the formation of folded mountains on the site of the abandoned geosyncline. The folding was accompanied by intrusive activity. The Lower Carboniferous sedimentary rocks of the study area are cut by granites of late Paleozoic age (Luppov, 1972, p. 716).

During the Permian Period, and possibly also even at the end of the Carboniferous, some sectors subsided as narrow fault-bounded depressions to form intermontane depressions; these were the sites of deposition of coarse redbeds, typical molasse. Such a depression is present in the area of the Central Kara Kum arch. Another is in the area of the Mary-Serakh zone of highs (fig. 7 and 13 of fig. 2). Contemporaneous deposits in the eastern part of the study area (Kugitang) are volcanics. See figure 10 for localities.

In Late Triassic time the Permian and Triassic sediments were affected by deformation (Kimmerian orogeny). These forces were not as strong as in the pre-Permian Hercynides, and there was no granitic intrusive activity.

Jurassic-Paleogene stage

With the Jurassic Period the study area entered the platform stage of its geological development. The rocks of this stage are covered everywhere by thick Cenozoic deposits and are known only from drilling. The latest Triassic is represented locally in the eastern part. Rhaetic continental deposits 6 to 70 m thick rest on eroded Paleozoic rocks and are separated from the overlying Lower Jurassic by another erosion surface.

The Lower Jurassic consists of clastic continental deposits; the Middle Jurassic is clastic-carbonate marine; and the Upper Jurassic is marine carbonates and evaporite and clastic deposits of lagoonal-continental origin. All three divisions are present in the Amu-Dar'ya region, but only the Upper Jurassic has been drilled in some parts of the Murgab region (figs. 7 and 11).

The Lower Jurassic has been recognized provisionally in the Amu-Dar'ya region where it is represented by conglomerates and in the Kushka region

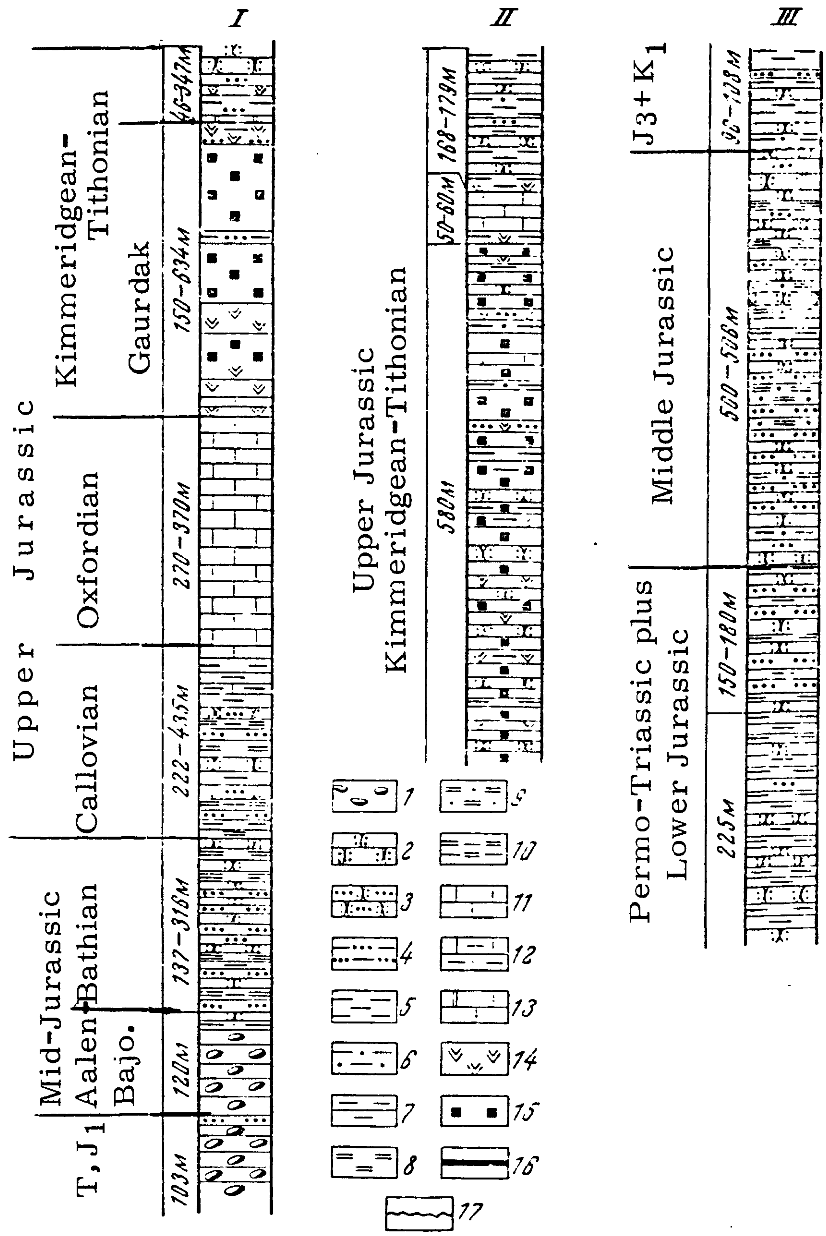


Figure 11.--Composite sections of the Jurassic of east and southeast Turkmenia (from Amanov, 1966).

I - Amu-Dar'ya region; II - Murgab region; III - Kushka region.

1 - Conglomerates; 2 - sands and sandstones; 3 - silty sandstones; 4 - siltstones; 5 - clays; 6 - sandy-clays; 7 - shales; 8 - argillites; 9 - sandy argillites; 10 - silty argillites; 11 - limestones; 12 - clayey limestones; 13 - dolomites; 14 - anhydrites; 15 - halite; 16 - coal 17 - erosion surface.

where it is sandstone, siltstone, and coal-bearing shale. In the Kugitang area it is conglomerate and sandstone, which fill low spots in the pre-Jurassic relief.

The Middle Jurassic is an upward continuation of the clastic sediments of the Lower Jurassic. Conglomerates with lenses of sandstone pass upward into sandstones, siltstones, and clays. Carbonates are present in places. Thickness of the Lower and Middle Jurassic combined is more than 1,000 m in the vicinity of Mary. It thins to less than 400 m at Chardzhou and less than 200 m on the Central Kara Kum regional high.

The Upper Jurassic is represented by the Callovian, Oxfordian, Kimmeridgean, and Tithonian series (Luppov and others, 1972, p. 73). Limestones of Callovian and principally Oxfordian age are the main reservoirs for oil and gas in the region, and evaporites of Kimmeridgean age are the main seal.

The lower Callovian, where present, consists of clastic sedimentary rocks. The upper Callovian is limestone in places, a precursor of the overlying Oxfordian limestones. For example, in the Dauletabad area, 300 to 350 m of Callovian limestones and dolomites rest on mildly metamorphosed shales of Permo-Triassic age (Mirzakhanov and others, 1975; Yanena and Mamedov, 1982).

The Oxfordian Series is a thick blanket of limestones. Total thickness of these and the underlying Callovian limestones reaches 500 to 600 m. The nature of these limestones is debated. Most contend that they are reefs (Ryzhkov and others, 1983; Il'in and Stroganov, 1981); whereas others have suggested that they are bioherms and biostromes on anticlines. The depression between some supposed reefs has turned out to be filled by anhydrite rather than by back-reef facies, suggesting that some of the reef-like morphology is erosional and not depositional (Luvishis, 1982).

Resting conformably on the Callovian-Oxfordian carbonates are evaporites of the Gaurdak Formation, which are Kimmeridgean and Tithonian in age. The evaporite basin covered an area of 300,000 km^2 (fig. 15a). These evaporites generally consist of a lower anhydrite, lower salt, middle anhydrite, upper salt, and upper anhydrite (Il'in and Stroganov, 1981). Elsewhere there are up to three salt members and four anhydrite members (Zharkov and others, 1982). Thickness of the lower anhydrite ranges from 10 to 15 m at the crests of highs on the underlying Oxfordian limestones to 120 to 140 m on the flanks. Total thickness of the Gaurdak evaporites is up to 650 m.

The Gaurdak evaporites have been interpreted as lagoonal deposits (Il'in and Stroganov, 1981). However, limestones interbedded with the salt contain marine fossils, suggesting that the evaporites are marine, even deep-water marine deposits (Sudarikov, 1981). Also indicative of a deep-water marine origin are the conformable relationships between the salt and the underlying and overlying sediments in a large part of the basin, the blanket character of the salt beds, their completeness and persistence over the area of the basin, and the massive texture of the salt (Gavril'cheva, 1985).

Total thickness of the Upper Jurassic section ranges from 1,500 m in the southeast part of the study area to less than 100 m on the Central Kara Kum regional high.

The Cretaceous System, just as the rest of the Jurassic-Paleogene Stage, is known only in the subsurface of the Amu-Dar'ya oil-gas province. The base of the Cretaceous is not well defined but is generally placed at the change from continental redbeds of Jurassic affinities to overlying marine deposits.

The Lower Cretaceous in the Amu-Dar'ya oil-gas province consists of up to 1,200 m of clastic and carbonate rocks of marine and lagoonal-continental origin. The Berriasian-Valanginian (?), Hauterivian (?), Barremian, Aptian, and Albian stages are represented. The Albian is subdivided into lower, middle, and upper parts (fig. 12).

The Berriasian-Valanginian (?) Stage consists of silty, clayey, organo-clastic, and dolomitic limestones, which are interbedded with dolomites, clays, and gypsum. Total thickness is 105 to 155 m.

Rocks referred to the Hauterivian (?) are subdivided on the basis of lithology into two parts. The lower is largely redbed siltstones and sandstones and is up to 140 m thick. The upper part consists of variegated siltstones, clays, and some limestone, marl, dolomite, and gypsum. Thickness is up to 70 m.

Sediments of Barremian age rest on the Hauterivian (?) and consist of three members. The lower is an oolitic limestone 70 m thick. The middle is clayey limestone, marl, and gray clay 80 m thick. The upper is largely dark gray clay and is 40 m thick. Total thickness of the Barremian in the area is 163 to 180 m.

Resting with apparent conformity on the Barremian are alternating oolitic and silty limestones, siltstones, marls, and clays of Aptian age. Their total thickness is 70 to 100 m.

The Albian in the Amu-Dar'ya oil-gas province is divided into five members, the lower three being lower Albian, and the fourth and fifth being middle and upper Albian, respectively. The first member in ascending order is dark gray clay, siltstone, and limestone up to 50 m thick. An erosion surface is present at the base of this unit. The second member is dark gray clay, which contains siltstone in the upper part; its thickness is up to 240 m. The third member is siltstone and clay and is an average of 60 m thick. The fourth member is composed of limestone, marl, clay, and siltstone and is 100 to 120 m thick. At the top of the Albian is 80 to 110 m of alternating siltstones and clays. Total thickness of the Albian is up to 580 m in the study area.

Maximum thickness of the Lower Cretaceous in the study area is more than 1,300 m.

The Upper Cretaceous sediments of the Amu-Dar'ya oil-gas province rest unconformably on the upper Albian; they consist of marine sandstones, siltstones, and shales. All stages except the Danian (Luppov, 1972, p. 231) are represented (fig. 13).

The Cenomanian is composed largely of gray quartz-feldspar sandstone. Some interbeds of clay are present. Thickness is 170 to 300 m.

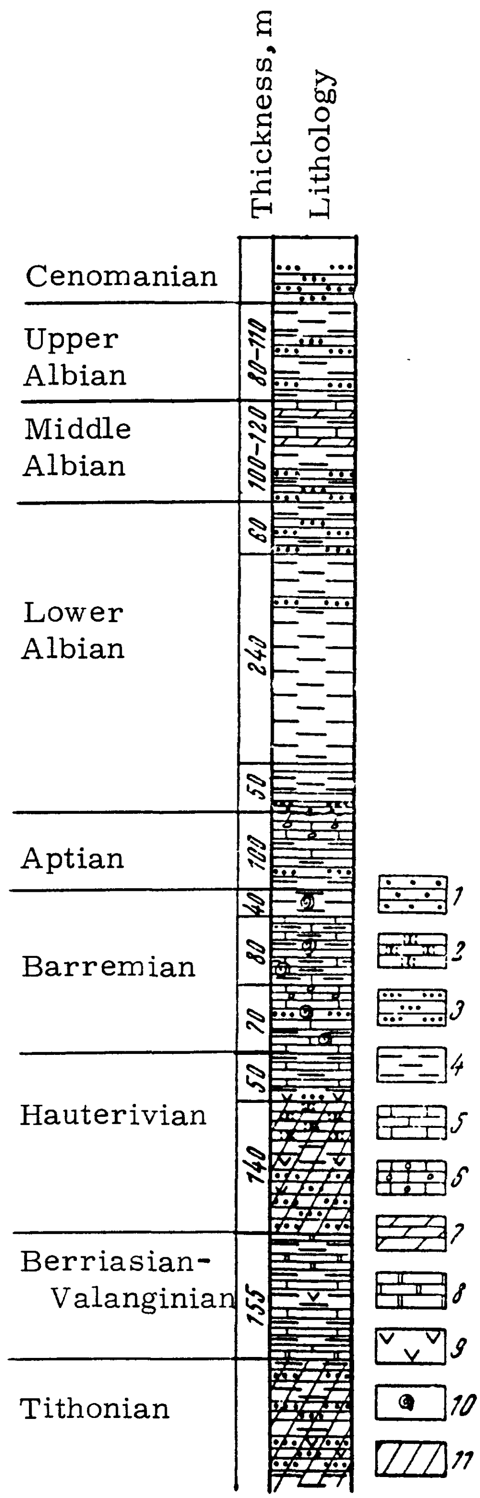
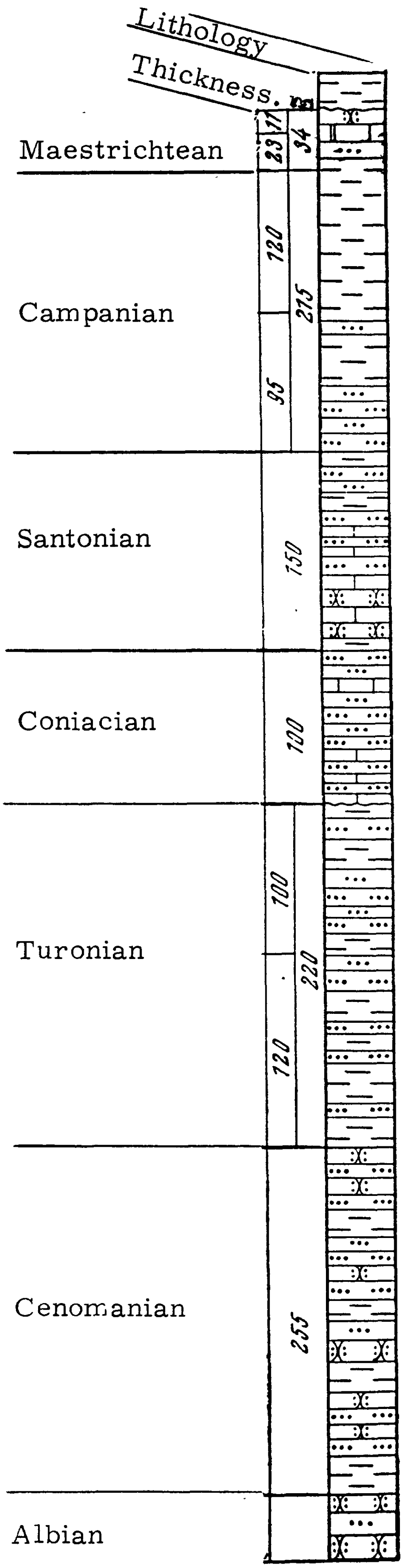


Figure 12.--Lower Cretaceous section of Mary-Bayram-Ali region (from Luppov, 1972).

1 - Gravels; 2 - sandstone; 3 - siltstone; 4 - clay; 5 - limestone; 6 - oolitic limestone; 7 - marl; 8 - dolomite; 9 - gypsum; 10 - marine fossils; 11 - redbeds.



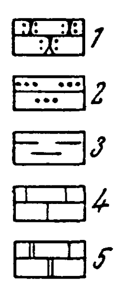


Figure 13.--Composite section of Upper Cretaceous of Amu-Dar'ya region (from Luppov, 1972).

1 - Sandstone; 2 - siltstone; 3 - clay; 4 - limestone; 5 - dolomitized limestone;

The Turonian is divided into upper and lower parts. Gray clays predominate in the lower part; they are interbedded with siltstone. Thickness of this member is up to 135 m. The upper part is largely sandstones and subordinate siltstones and clays; thickness is 80 to 112 m. Total thickness of the Turonian is up to 247 m.

The Coniacian consists of sandy-clayey rocks and a few beds of limestone. Thickness increases from 20 to 50 m in the south to 164 m in the north. In this same direction there is an increase in the content of sandstone in the section.

The Sàntonian section is composed of clays, siltstones, sandstones, and limestones. In the south siltstones predominate in the lower part of the section and clays in the upper. In the north, clays predominate. Thickness ranges from 58 to 160 m.

The Campanian, as thick as 260 m in the southern part of the area, is largely siltstone and clay; some limestone is present. To the north in the Amu-Dar'ya region, it consists of a lower siltstone and clay unit up to 95 m thick and an upper clay unit 120 m thick.

The Maestrichtean is largely sandstone in its lower part, and carbonates are present in the upper part. Total thickness is up to 34 m.

Total thickness of the Upper Cretaceous is more than 1,300 m in the Mary area and more than 1,500 m to the east in the Beshkent downwarp. It thins to less than 400 m on the Central Kara Kum arch where limestone is more prominent in the section.

The Paleogene crops out at some places in the Amu-Dar'ya valley below Chardzhou but is known mostly from drilling. The Paleocene, Eocene, and Oligocene are represented in the section.

The Paleocene in the northwest part of the region consists of limy clay and marl up to 25 m thick. In the central, Karabekaul area are largely gypsum-bearing limestones, which contain beds of sandstone. Their thickness reaches 100 m. In the southeast in the Ak-Ayry area, the Paleogene is represented by dolomite and gypsum with a silty clay member at the top; its thickness here is 110 m (fig. 14). The "Bukhara beds" of Soviet Central Asia are carbonates of this age.

The Eocene sediments are largely clays; they are divided into lower, middle, and upper divisions. The lower Eocene rests conformably on the Paleocene in most places and consists of gray limy clay 36 to 67 m thick. The middle Eocene is a gray marl up to 36 m thick. The upper Eocene consists of gray clays and subordinate sandstone and siltstone. Thickness of the upper Eocene ranges from 9 to 400 m, as shown in figure 14. An erosion surface is at the top.

The Oligocene sediments rest on an erosion surface that truncates various horizons of the Eocene section. They are largely variegated clays, but beds of sandstone and gypsum are present also. Thickness of the Oligocene ranges from 0 to 82 m.

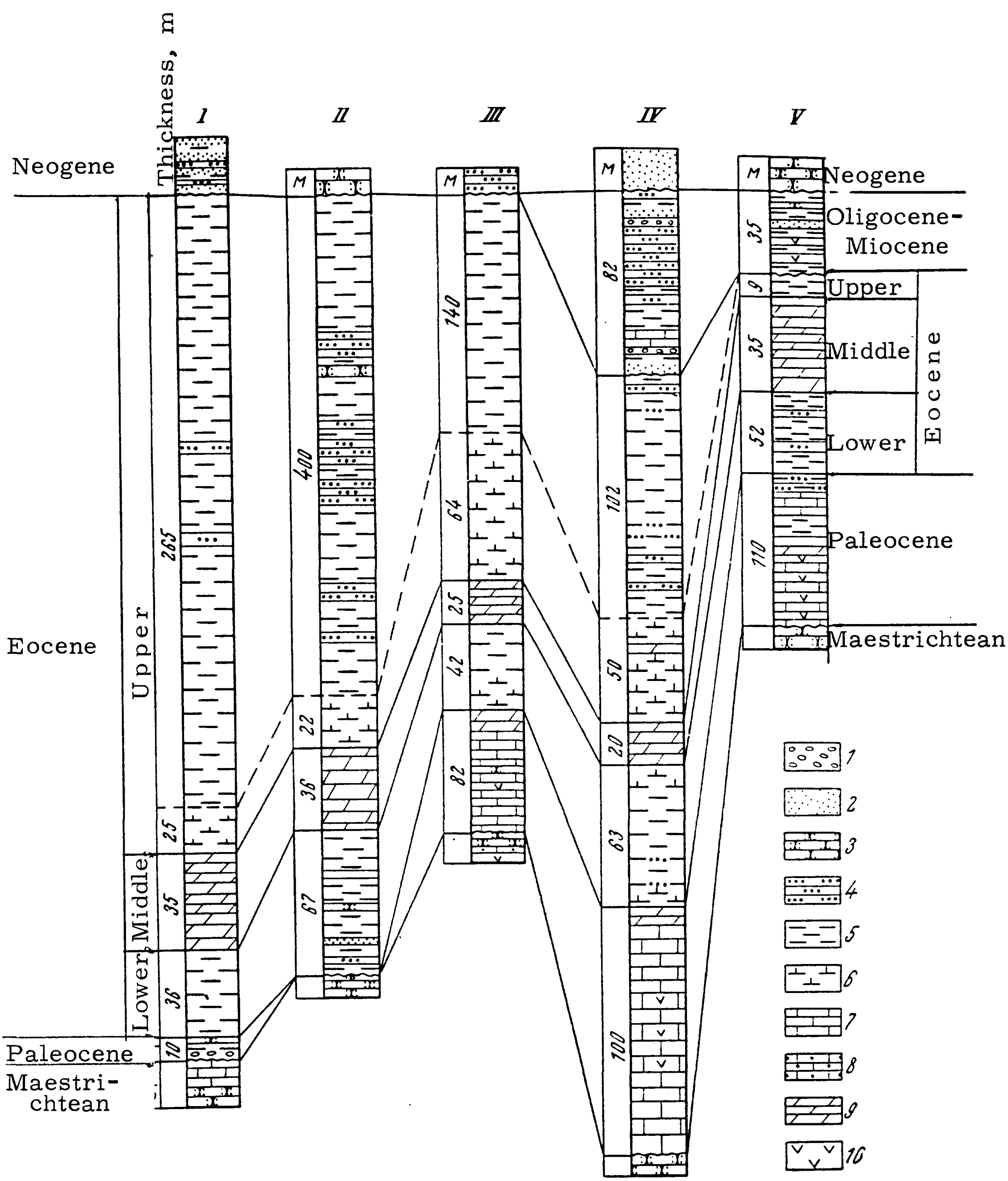


Figure 14.--Correlation of Paleogene sections of the Amu Dar'ya region (from Luppov, 1972).

1 - Gravels; 2 - sands; 3 - sandstone; 4 - siltstone; 5 - clay; 6 - limy clay; 7 - limestone; 8 - sandy limestone; 9 - marl; 10 - gypsum. I - Darganata, II - Kabakly, III - Farab-Narazym, IV - Karabekaul, V - Ak-Ayry.

Neogene-Quaternary stage

The Neogene sediments are distributed over almost the entire Amu-Dar'ya oil-gas province. They are absent only in a few places where erosion has exposed underlying Paleogene rocks.

The Neogene section is composed largely of continental clayey-sandy rocks. Red colors are prominent in the lower part and gray in the upper. Thickness ranges from 100-300 to 1,000-1,500 m. There is a gradual transition from the upper Oligocene to the Neogene, but within the Neogene are several erosional breaks where Miocene and Pliocene sediments rest directly on Paleogene and Mesozoic rocks.

The Neogene rocks in the province are divided clearly into three parts. The lower spans the lower and part of the middle Miocene. It is the Karagaudan Formation (fig. 15). The middle part consists of several contemporaneous formations such as the Kazganchay; they are middle Miocene-middle Pliocene in age, and thickness exceeds 1000 m in places. The upper part is assigned to the upper Pliocene.

Quaternary and Holocene sediments are present throughout the region. They are continental fluvial and eolian deposits. Their total thickness is less than 100 m.

PETROLEUM GEOLOGY

Plays

Five plays are recognized in the sedimentary cover of the Amu-Dar'ya gas-oil province.

The Lower-Middle Jurassic play consists of alternating clays, sandstones, and siltstones. Thickness is 100 to 400 m. Gas has been found in the Kagan-Mubarek area, Chardzhou oil-gas region, and in the Beurdeshick and Naip areas (fig. 16). Structures on this play have been found to attenuate upward; they are now being actively explored, as most of the structures expressed higher in the section have already been examined (Sokolov and Zelenin, 1979).

The Upper Jurassic play occurs throughout the province. In much of the area this play consists of Callovian-Oxfordian carbonate deposits, which are up to 500 m thick. The seal is Kimmeridgean-Tithonian salt. The carbonate deposits of this play are commonly a reef facies. This is the main play of the Amu-Dar'ya gas-oil province. It is gas productive where the salt seal is present (fig. 17); otherwise, the gas has migrated into the overlying Cretaceous plays (Dikenshteyn, 1983, p. 144). This play is overpressured where the salt is more than 100 m thick, and the anomaly factor reaches 1.75 where the salt is more than 800 m thick (Alekhin, 1980).

The Lower Cretaceous play consists largely of alternating sandstones, clays, and siltstones. The seal is a clay unit of late Aptian and Albian age, which also separates this play from the overlying Albian-Cenomanian play. This Lower Cretaceous play is gas-bearing in most of the fields of the Bukhara step, Khiva downwarp, Mary-Serakh zone of highs, Badkhyz-Karabil zone of highs, and the Central Kara Kum arch.

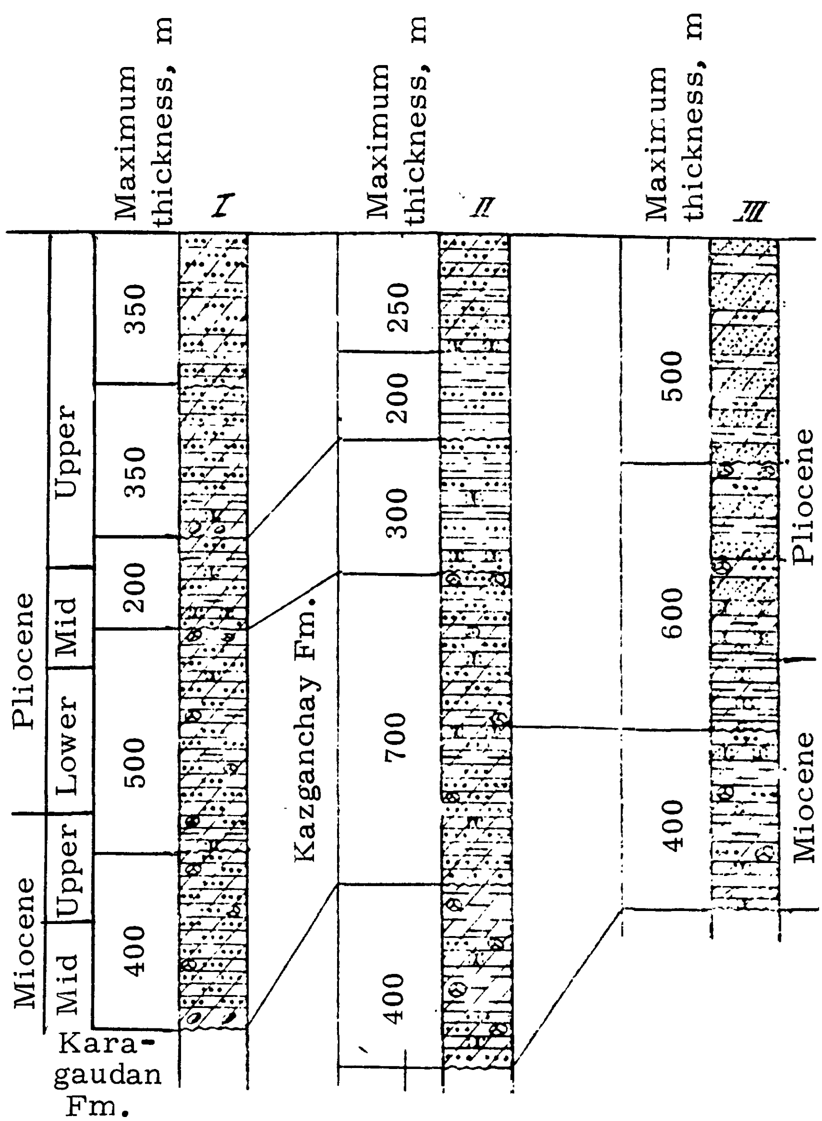


Figure 15.--Composite Neogene sections of Southeast Turkmenistan (from Luppov, 1972).

I - Badkhyz and Karabil, II - west part of Southeast Kara Kum, III - east part of Southeast Kara Kum.

1 - Conglomerate; 2 - gravels; 3 - sands; 4 - sandstone; 5 - silts; 6 - siltstone; 7 - clay; 8 - marl; 9 - limestone; 10 - nodular carbonates; 11 - redbeds.

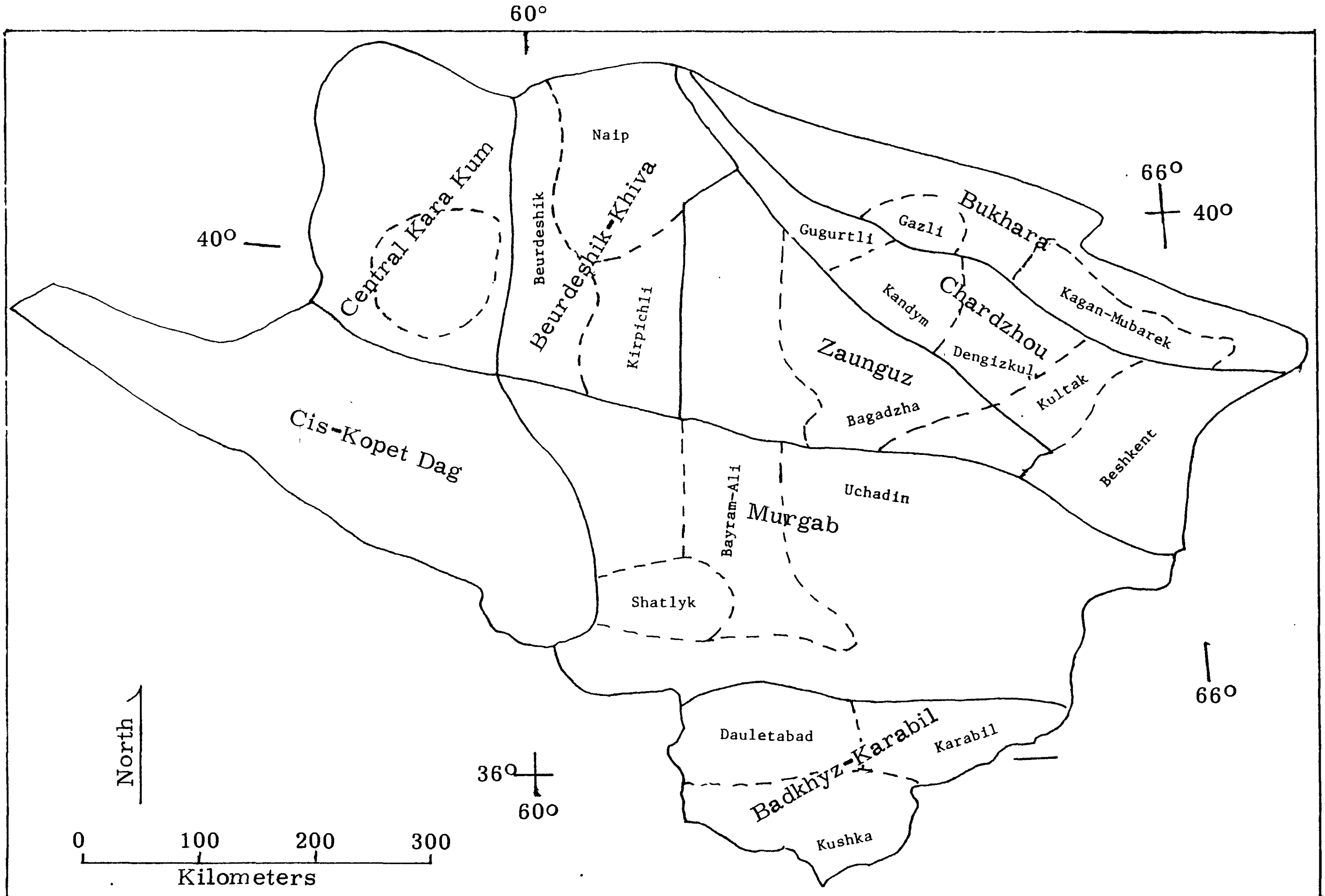
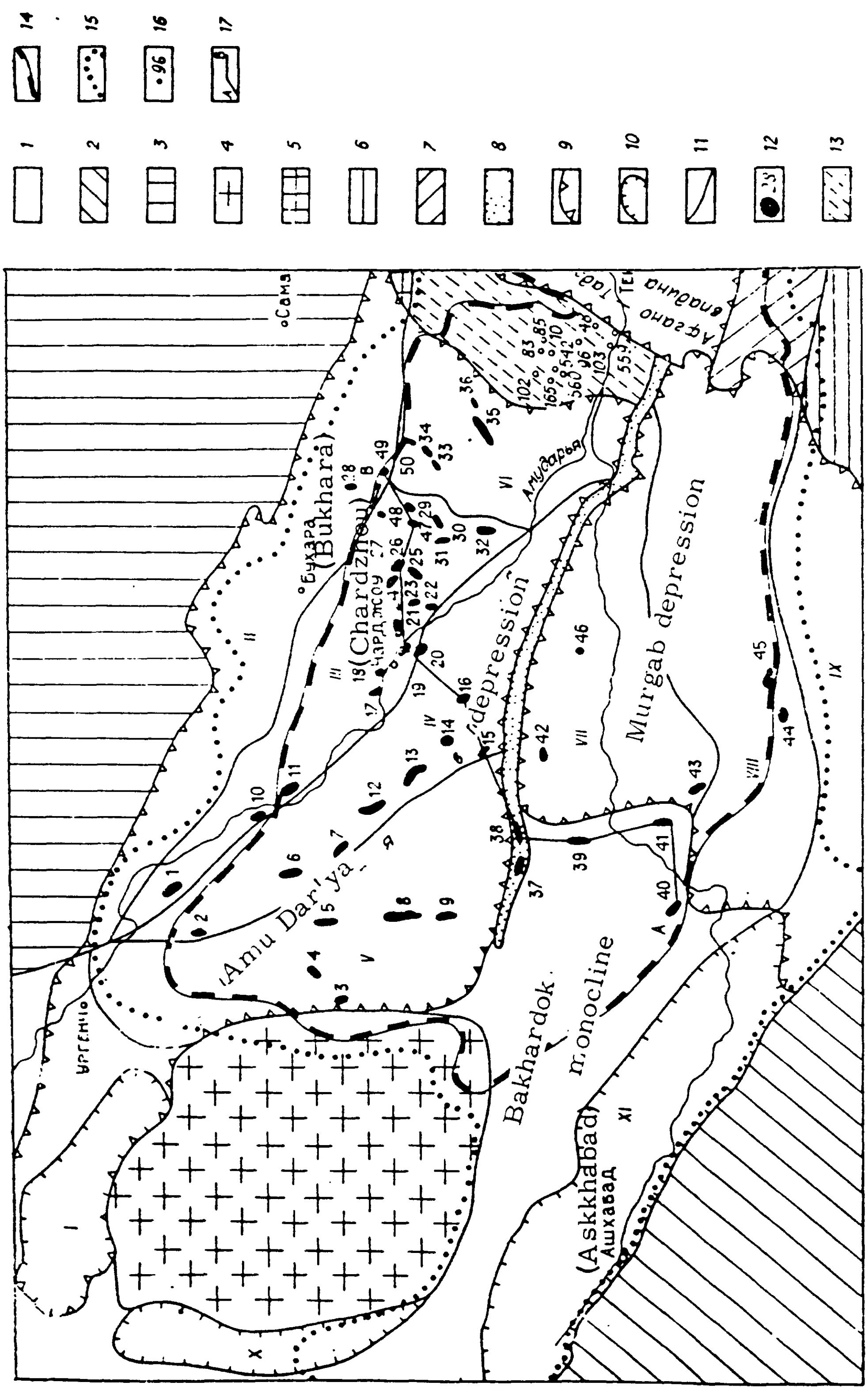


Figure 16.. Map showing oil-gas regions (large type) and areas (small type). This map is taken from figure 2.



(Bukhara)
(Chardzhou)
Amu Dar'ya depression
Murgab depression
Bakhardok monocline
(Askkhabad)

Figure 17

Fig. 17. Map showing distribution of Jurassic salt in the western part of the Central Asian evaporite basin (from Zharkov and others, 1982). 1-Depressions and downwarps; 2-Kopetdag anticlinorium; 3-Kyzyl Kum-Nuratin zone of highs; 4-Central Kara Kum arch; 5-Zeravshan-Gissar mega-anticlinal zone; 6-Mirza-Valeng high; 7-North Afghan step; 8-Repetek-Kelif zone of highs; 9-boundaries of depressions; 10-boundaries of downwarps; 11-boundaries of tectonic elements; 12-oil exploration areas (1-Koshabulak, 2-Koshuy, 3-Mesitliy, 4-Kirpichli, 5-Gagarin, 6-Babaarap, 7-Yuzhnyy Mergen, 8-Yuzhnaya Unguz, 9-Severnaya Cheshmin, 10-Severnaya Gugurtli, 11-Kabakly, 12-Dzhillikum, 13-Bagadzha, 14-Baygushli, 15-Malay, 16-Karaul-Kuyu, 17-Gadyn, 18-Farab, 19-Sakar, 20-Yuzhnyy Sakar, 21-Kishtuvan, 22-Narazym, 23-Samantepe, 24-Dengizkul, 25-Metedzhan, 26-Urtabulak, 27-Ispanly, 28-Shurtepe, 29-Pamuk, 30-Kultak, 31-Tangikuduk, 32-Sundukli, 33-Kamashi, 34-Beshkent, 35-Alyaudy, 36-Kuruk, 37-Keliy, 38-Sharapli, 39-Bayram-Ali, 40-Shatlyk, 41-May, 42-Ugadzhi, 43-Yuzhnaya Iolotan, 44-Sandykachi, 45-Karakel, 46-Kulach, 47-Zevarda, 48-Darbaza, 49-Maymanaktau, 50-Kungurtau): 13-Southwest Gissar mega-anticline; 14-limits of distribution of the salt; 15-boundary of Late Jurassic evaporite basin; 16-potassium-salt exploration wells.

I-VI - tectonic elements of the Amu-Dar'ya depression: I - Dar'yalyk-Daudan downwarp, II-Bukhara step, III-Chardzhou step, IV-Izmail-Karabekaul zone of downwarps, V-Zaunguz zone of downwarps, VI-Beshkent downwarp; VII-XI - tectonic elements of the Murgab depression: VII-Zakhmet monocline, VIII-Sandykachin zone of downwarps, IX - Badkhyz-Karabil step; X-Verkhneuzboy downwarp, XI-Cis-Kopetdag foreland downwarps.

The Albian-Cenomanian play is gas-bearing on the Bukhara step, Khiva downwarp, and Central Kara Kum arch. The reservoirs are sandstones and siltstones, and the seal is a Turonian clay unit.

The Paleogene play is prospective in the northeast part of the study area. Several commercial pools have been found in the so-called Bukhara beds (Sokolov and Zelenin, 1980).

Differential tectonic movements in the region continued over the entire Mesozoic and Cenozoic Eras, much of it during late Tertiary time in response to Alpine tectonism. Consequently, much of the trap formation and filling is late in geologic time and is apparently in progress at present (Yanena and Mamedov, 1982).

Gas-oil Regions and Areas

Within the Amu-Dar'ya oil-gas province are four gas regions and two gas-oil regions. These are in turn divided into gas and gas-oil areas. In addition, there is one independent gas area and one prospective oil-gas region (table 1 and figs. 2 and 16).

The Central Kara Kum independent gas area (fig. 16 and H in fig. 2) is on the Zeagli-Darvaza high on the Central Kara Kum arch (figs. 2 and 18). Gas fields occur here on small uplifts that are 10 km or less in long dimension (fig. 19). The pays are discontinuous sandstones of Callovian, Hauterivian, Barremian, Aptian, Albian, Cenomanian, and Turonian age. More than 20 pays have been found. Reserves are not large.

The Cis-Kopet Dag prospective oil-gas region (fig. 16 and A in fig. 2) includes the areas of the Bakhardok flank and the Cis-Kopet Dag foredeep (fig. 18). Shows of oil and gas have been found in Jurassic and Cretaceous sediments at several places on the Bakhardok flank, but no commercial discoveries have been made. No anticlines have been found in spite of extensive geophysical surveys. The Cretaceous here, however, is similar to that farther east in southeastern Turkmenia where it is highly productive, as for example in Shatlyk field (Mavyev and Nedirov, 1982).

The Beurdeshik-Khiva gas region (fig. 16 and B in fig. 2) includes the Beurdeshik step on the west and the Khiva downwarp on the east (3 and 4 of fig 2). Within it are three gas areas. The Beurdeshik gas area coincides with the Beurdeshik step, the Naip gas area with the north half of the Khiva downwarp, and the Kirpichli gas area with the south half. The map (fig. 20) given in Zhabrev (1983, p. 251) places the Beurdeshik field on the east margin of the Central Kara Kum arch and identifies three structural highs within the area of the Khiva downwarp.

The Beurdeshik gas area (fig. 16 and B,a in fig. 2) has not been studied extensively, and only the Beurdeshik gas field has been discovered here. Its reserves were 1.6 tcf in 1980. Pools are present in Lower and Middle Jurassic carbonate and clastic sediments and above the salt in Lower Cretaceous clastic sediments (fig. 21).

Table 1.--Oil-gas regions and areas of the Amu-Dar'ya oil-gas province.

Regions Areas	Area 1,000 km^2	Maximum thickness of sediments, km	Main plays	Prospective plays	Lithology of reservoirs
Central Kara Kum	9	2	K		ss, sts
Cis-Kopet Dag	55	7		J, K	
Beurdeshik-Khiva	37	4	J_3, K	J_3, K	ls, ss
Beurdeshik	13	3	J_3, K	J_3, K	ls, ss
Naip	10	3	J_3, K	J_3, K	ls, ss
Kirpichli	14	4	J_{1-2}	J_{1-2}	ls, ss
Zaunguz	38	5	J_3	J_3	ls, ss
Bagadzha	14	4	J_3	J_3	ls
Chardzhou	40	5	J_3	J_3	ls
Gugurtli	4	3	J_3	--	ls
Kandym	6	4	J_3	J_3	ls
Dengizkul	8	4	J_3	J_3	ls
Kultak	5	4	J_3	J_3	ls
Beshkent	15	5	J_3	J_3	ls
Bukhara	31	2	J_3, K	J_3, K	ls
Gazli	3	2	K	--	ss, sts
Kagano-Mubarek	6	2	J_3, K	J_3, K	ls, ss
Murgab	90	7	K_1	J_3, K_1	ls, ss
Shatlyk	5	5	K_1	K_1	ls, ss
Bayram-Aliy	14	5	K_1	K_1	ls, ss
Uchadzhi	16	5	K_1	K_1	ls, ss
Badkhyz-Karabil	25	3	K_1	K_1	ls, ss
Dauletabad	8	3	K_1	K_1	ss
Karabil	6	3	K_1	K_1	ss
Kushka	3	2	J_3, K	--	ss

K - Cretaceous; K_1 - Lower Cretaceous; J_1 - Lower Jurassic; J_2 - Middle Jurassic; J_3 - Upper Jurassic; ss - sandstone; sts - siltstone; ls - limestone

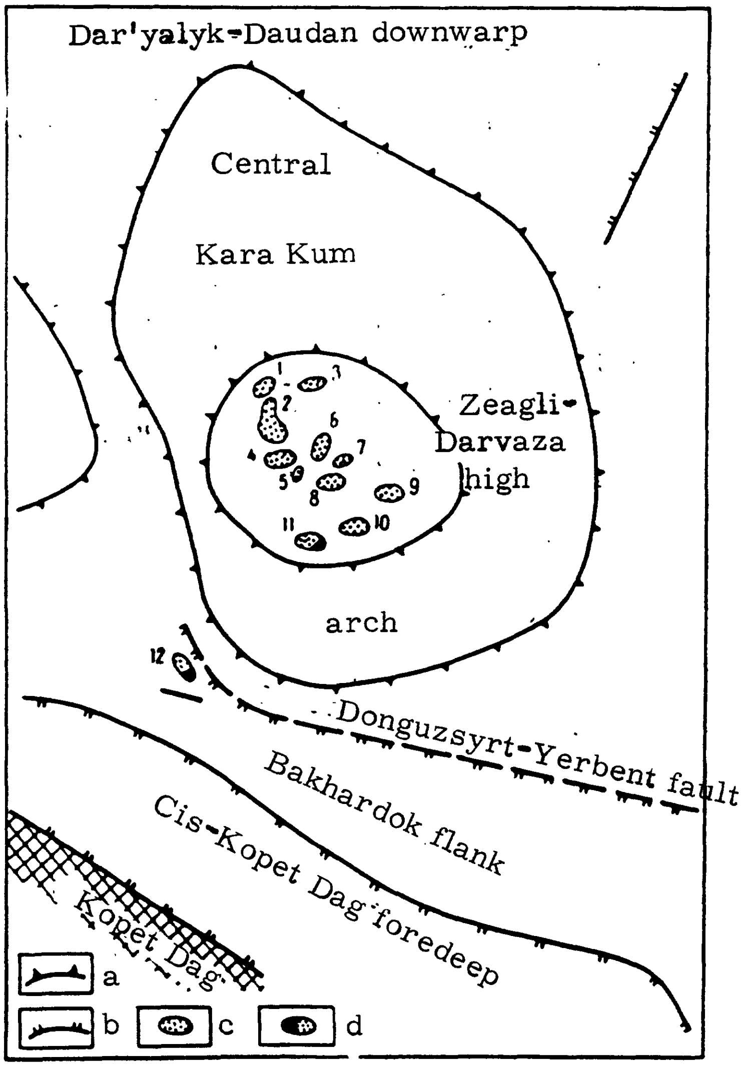


Figure 18.--Sketch map of west part of Amu-Dar'ya oil-gas province (from Zhabrev, 1983).

a - Boundaries of main tectonic elements; b - faults, c - gas fields, d - oil-gas fields.

Fields: 1 - Chaldzhul'ba, 2 - Shiikh-Darvaza, 3 - Vostochnoye Akkui, 4 - Topzdzul'ba, 5 - Atabay, 6 - Topordzhul'ba, 7 - Chimmerli, 8 - Chaskhyn, 9 - Sakarchaga, 10 - Kuruk, 11 - Koyun-Sharlyk, 12 - Modar.

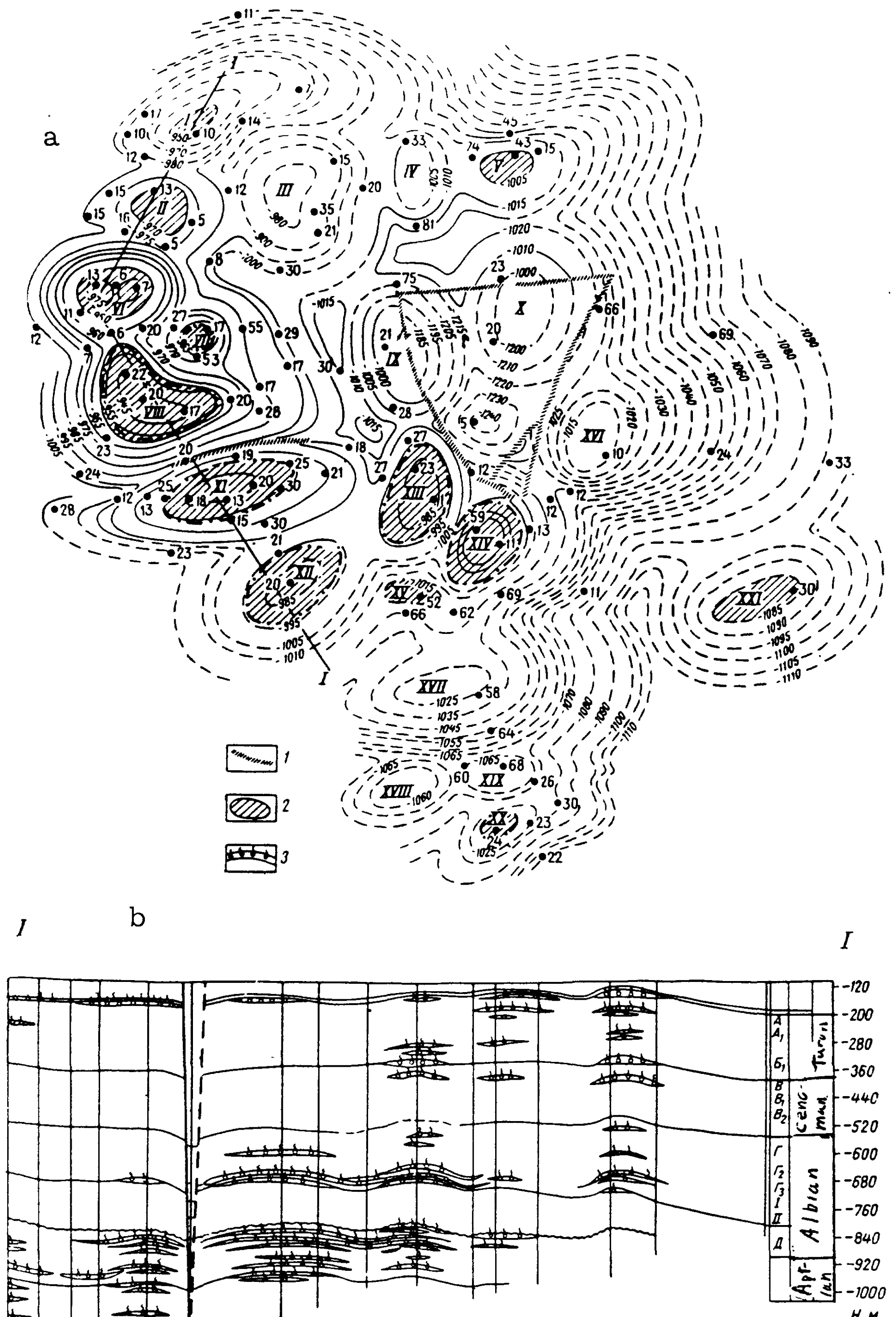
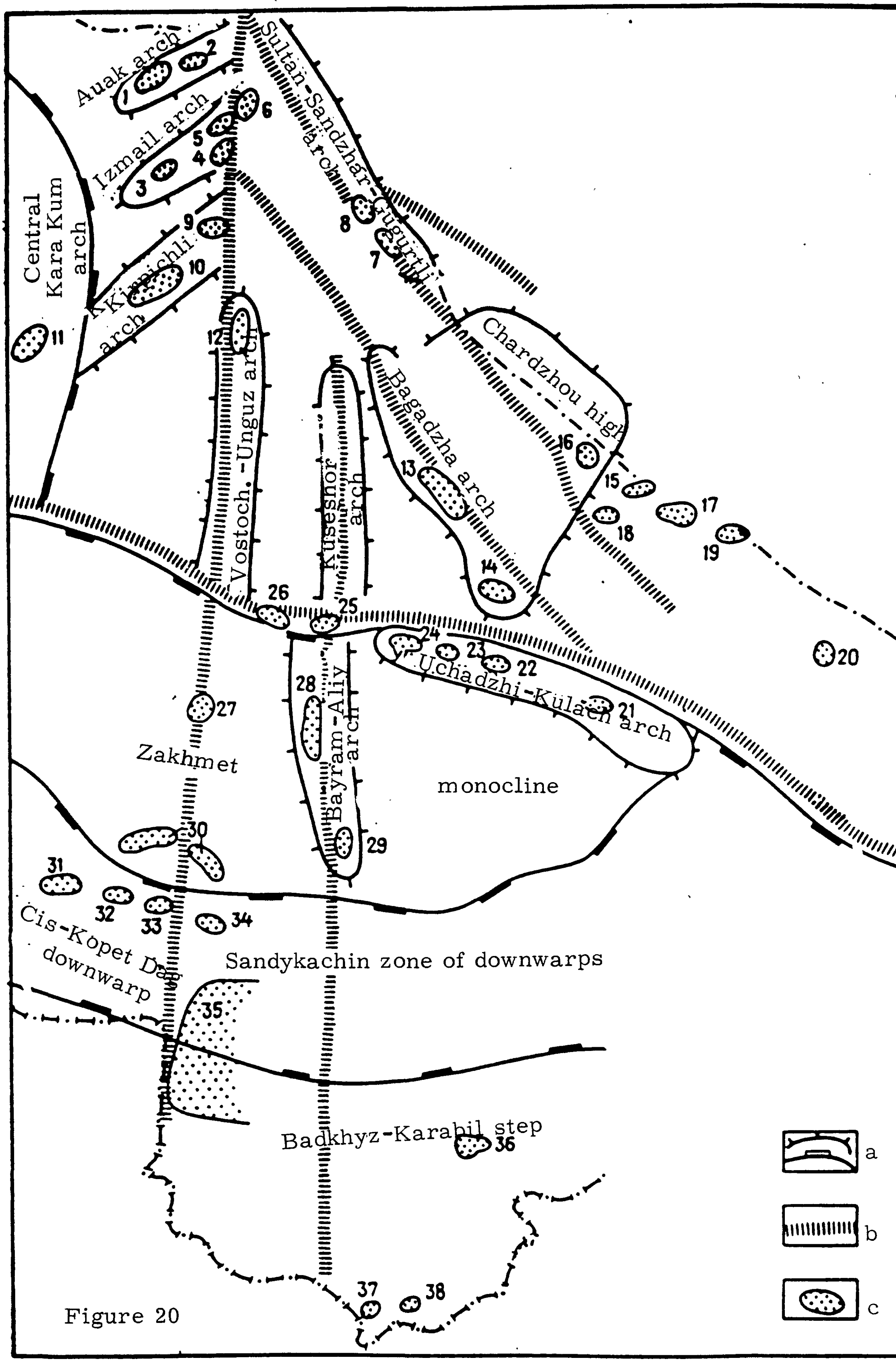


Figure 19.--Zeagli-Darvaza group of gas fields.

a - Structure map on top of lower Aptian sediments (horizon VI); b - profile section (from Zhabrev, 1983).

1 - Faults, 2 - commercial gas fields, 3 - gas. Local highs: I - Chaldzhul, II - Darvaza, III - Dzharal, IV - Akkui, V - Vostochnoye Akkui, VI - Takyr, VII - Prishiikh, VIII - Shiikh, IX - Dar'yalyk-Takyr, X - Gugurtli, XI - Topdzhul'ba, XII - Atabay, XIII - Topordzhul'ba, XIV - Chimmerli, XV - Chashkhyn, XVI - Shikhanli, XVII - Yuzhnyy Chashkhyn, XVIII - Vostochnyy Koyun, XIX - Severnyy Kuruk, XX - Kuruk, XXI - Sakarchaga.


Auak arch
Izmail arch
Central Kara Kum arch
Kirpichli arch
Sultan-Sandzhar-Gugurtli arch
Vostoch.-Unguz arch
Kuseshor arch
Bagadzha arch
Chardzhou high
Uchadzhi-Kulach arch
Bayram-Aliy arch
Zakhmet
monocline
Cis-Kopet Dag downwarp
Sandykachin zone of downwarps
Badkhyz-Karabil step
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
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32
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34
35
36
37
38
a
b
c
Figure 20

Figure 20.--Sketch map of eastern Turkmenia (from Zhabrev, 1983).

a - Boundaries of tectonic elements; b - faults; c - gas and gas-condensate fields:

1 - Achak, 2 - Severnyy Achak, 3 - Stikhy, 4 - Yuzhnyy Naip, 5 - Naip, 6 - Severnyy Naip, 7 - Gugurtli, 8 - Severnoye Gugurtli, 9 - Severnoye Balkui, 10 - Karpichli, 11 - Beurdeshik, 12 - Gagarin, 13 - Bagadzha, 14 - Malay, 15 - Kishtuvan, 16 - Farab, 17 - Samantepe, 18 - Sazar, 19 - Metedzhan, 20 - Sundukli, 21 - Beshkizyl, 22 - Vostochnoye Uchadzhi, 23 - Uchadzhi, 24 - Sayrab, 25 - Sharapli, 26 - Keli, 27 - Yelan, 28 - Bayram-Aliy, 29 - Maysk, 30 - Shatlyk, 31 - Tedzhen, 32 - Vostochnyy Tedzhen, 33 - Mollaker, 34 - Shorkel, 35 - Dauletabad-Donmez (Sovetabad), 36 - Karabil, 37 - Islim, 38 - Karachop.

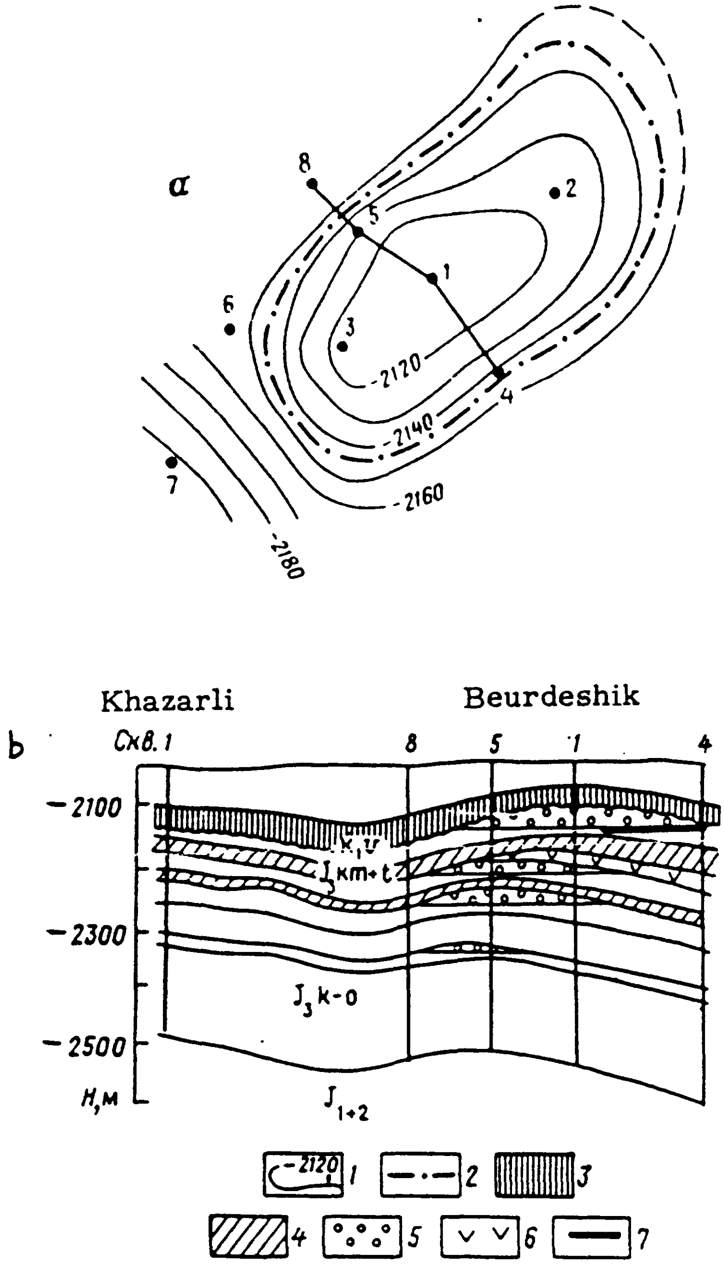


Figure 21.--Beurdeshik gas-condensate field (from Zhabrev, 1983).

a - Structure map on top of the Cretaceous sediments; b - geologic section.

1 - Structure contours, m; 2 - margin of gas field; 3 - clay seal;
4 - clay-anhydrite seal; 5 - gas; 6 - salt; 7 - oil ring.

Several gas-condensate fields have been discovered in the Naip gas area (fig. 16 and B,b in fig. 2). The fields are multipay. Reservoirs of the Upper Jurassic are limestones and carbonates, and those of the Lower Cretaceous are sandstones and siltstones. Naip field (5 in fig. 20) has 21 productive horizons, the most important of which are Lower Cretaceous. Total production for this field by 1980 was 3.3 tcf. and reserves were 2.7 tcf. The Achak field has 13 productive horizons, also largely in the Lower Cretaceous (fig. 22). It had produced 3.2 tcf as of 1980, and reserves were 2.2 tcf (table 2).

The Kirpichli gas area (fig. 16 and B,c in fig. 2) has not been extensively explored. Only two gas fields, the Kirpichli (4.8 tcf reserves) and and the Severnoye Balkui (1.8 tcf reserves), have been discovered here (fig. 18). The gas pools are in Upper Jurassic carbonate sediments.

The Zaunguz gas region (fig. 16 and C of fig. 2) includes the Zaunguz downwarp, the Malay-Bagadzha saddle and the Karabekaul downwarp (5, 6, and 7 of fig. 2). In its eastern part is the Bagadzha gas area. On its western border is the Vostochno-Unguz zone of highs (12 of fig. 2 and VII of fig. 5), which contains the Gagarin gas field (fig. 18) with 0.8 tcf of proved and inferred reserves.

The Bagadzha gas area (fig. 16 and C,a in fig. 2), which coincides with the Malay-Bagadzha saddle, contains the Bagadzha (0.6 tcf reserves) and Malay (1.2 tcf proved and inferred reserves) fields (fig. 20). These fields are on the same anticline, and their pools are in Upper Jurassic limestone.

The Chardzhou gas-oil region (fig. 16 and D of fig. 2) includes the area of the Chardzhou step and the Beshkent downwarp (8 and 10 of fig. 2). Four gas areas and one gas-oil area are recognized within it. The map given by Zhabrev (1983, p. 268) for the fields of the Chardzhou step (fig. 23) differs somewhat from that of figure 2, because the southwest border of the step in Zhabrev is drawn along the border between Uzbekistan and Turkmenistan.

The Gugurtli gas area (fig. 16 and D,a in fig. 2) is host to several fields (7, 8 in fig. 20; 4 to 7 in fig. 23). In the Dayakhatyn and Kul'beshkak fields, only Upper Jurassic limestones are productive. In the rest of the fields of this area, the Lower Cretaceous sandstones in addition are productive.

The Kandym gas area (fig. 16 and D,b in fig. 2) contains several fields, the largest of which is the Kandym gas-condensate field, where reserves are more than 5 tcf (fig. 7 and 21). This field has a complex outline (fig. 24), the dimensions being about 20 by 25 km and closure at 100 m. Three pools are present in Upper Jurassic limestones.

The Dengizkul gas-oil area (fig. 16 and D,c in fig. 2) includes the large Dengizkul gas-condensate field (reserves greater than 4 tcf) and Urtabulak gas-condensate field (reserves of more than 3 tcf). Production is largely from very porous reef limestones. The gas is sour. Urtabulak field has an oil ring (fig. 25).

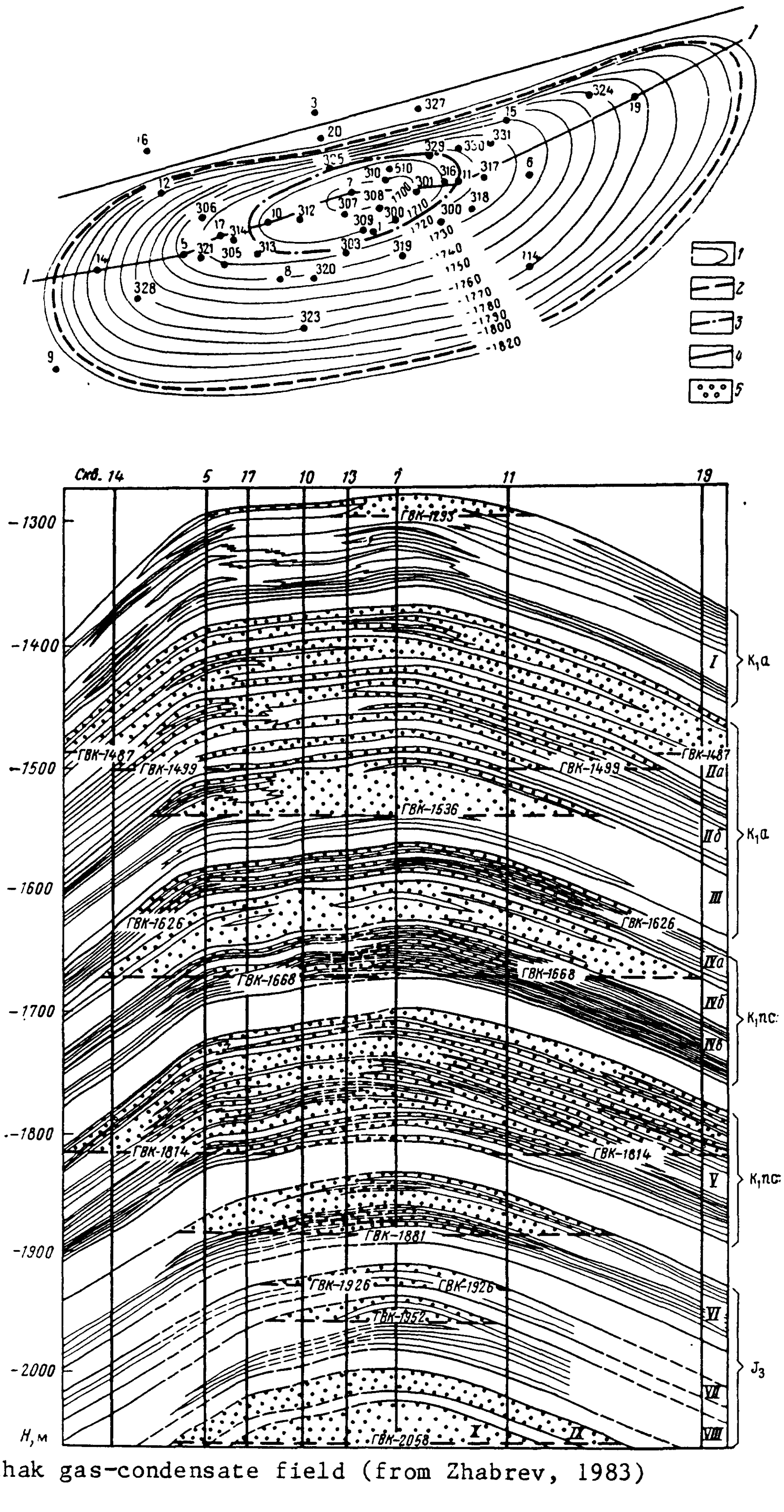


Figure 22.--Achak gas-condensate field (from Zhabrev, 1983)

a - Structure map on top of horizon V of the Lower Cretaceous; b - geologic section.

1 - Structure contours, m; 2 - outer margin of pool; 3 - inner margin of pool; 4 - fault; 5 - gas.

Table 2. Data on fields of the Amu-Dar'ya oil-gas province of Soviet Central Asia (from Zhabrev, 1983)

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, $10^6 m^3$	Gas reserves as of 1/1/80, 10^6 m^3: A+B+C_1	Gas reserves as of 1/1/80, 10^6 m^3: C_2
Achak	1966	1966													92 081	63 282	—
			ГК	Apt. I	1420	Sandst.	19	20,4	176	—1293	14,1	69,1	17,1	—	710	157	—
			ГК	IIa	1500	»	23,2	23,3	289	—1487	16,1	73,7	13,6	370 (18,8)	20 225	16 281	—
			ГК	II6	1560	»	10,5	22,1	347	—1499	16,3	75,0	13,1	240	5 611	3 310	—
			ГК	III	1620	»	12,5	24,7	308	—1534	17,0	76,4	16,2	608 (18,8)	5 219	4 781	—
			ГК	Neoco. IVa	1690	»	5,16	15,7	74	—1626	17,8	78,7	15,7	850 (25,4)	139	1 792	—
			ГК	IV6	1720	»	21,5	22,4	458	—1668	18,5	79,9	15,7	500 (16,1)	15 679	10 322	—
			ГК	IVв	1760	»	6,7	15,0	30	—1668	18,5	80,6	15,7	350 (12,6)	309	1 238	—
			ГК	V	1830	»	28,6	21,9	351	—1814	20,2	84,4	21,2	560 (18,8)	36 505	18 596	—
			ГК	U. Juras. VI	1960	»	15	19,5	38	—1881	20,6	87,1	22	390	4 639	2 387	—
			ГК	VII	2030	Limest.	5,3	15,6	29	—1942	21,0	88,7	12,2	85	45	951	—
			ГК	VIII	2060		4,6	14,6	26	—1952	21,3	89,5	12,2	230	145	183	—
			ГК	IX	2120	Sandsto.	12,1	15,9	29	—2058	22,3	92,1	12,2	200 (12,6)	2 202	2 075	—
			ГК	X	2155	»	10,4	14,4	27	—2058	22,4	92,7	12,2	135	653	1 209	—
Severnyy Achak	1968	1972													8 530	5 738	1 467
			ГК	Apt. IIa	1660	»	8,48	18	232	—1500	16,5	73,7	15,3	270	1 499	312	—
			ГК	II6	1730	»	9,5	18	3,5	—1583	17,8	78	5,8	430	2 064	765	—
			ГК	III	1800	»	18,9	22,6	303	—1641	18,4	80,4	20,1	390	3 365	1 796	—
			ГК	Neoco. IV6	1870	»	6,7	19,7	178	—1733	19,3	80,9	19,7	284	424	1 437	—
			ГК	V	2040	»	4,17	19,7	70	—1828	20,2	85	30,9	345	298	360	1 467
			ГК	U. Jurass. VI	2120	Limesto.	3,6	17,5	36	—2031	22,6	91	30,9	280	880	1 068	—
			ГК	VII	2158	»	2,8	14,2	29	—2076	22,7	88,7	30,9	280	—	—	—
Naip	1970	1972													94 472	75 939	3 989
			ГК	Apt. I	1650	Sandstone	6,5	17,7	17	—1525	17,4	77,0	26	50	146	—	698
			ГК	IIa	1700	»	4,8	16,8	—	—	18,5	80	26	50	—	—	1 681
			ГК	IIa₂	1740	»	8,8	16,8	10	—1647	18,7	80,1	26	150	2 689	1 704	—
			ГК	II6	1790	»	1,1	16	10	—1677	18,9	81,5	26	—	24	—	148
			ГК	Neoco. III	1849	»	20	18,1	163	—1773	20,0	84,0	26	850	26 296	14 904	—
			ГК	IVa	1920	»	4,4	15,3	10	—1808	20,6	86,1	31	500	—	—	1 462
			ГК	IV6	1954	»	21	17	90	—1884	21,0	87,1	31	126 (16)	17 795	12 245	—
			ГК	V	2120	»	—	16,6	10	—2050	22,7	92,2	31	—	36 347	29 853	—
			ГК	Va	2190	»	8,9	18,4	34	—2105	22,9	94,2	31	258 (20)	—	—	—
			ГК	Jura. VI	2250	»	17	17,8	24	—2162	23,4	95,8	39	140 (8)	3 055	4 983	—
			ГК	VIIIa	2390	»	9	10,5	10	—2290	25,4	100,5	39	99 (18)	2 440	630	—
			ГК	VIII6	2440	»	9	10,5	10	—2300	25,8	101,9	39	99 (18)	—	—	—
			ГК	IX	2471	»	18	15,5	163	—2378	26,7	103,3	39	470	5 680	4 620	—
			ГК	X	2501	»	18	15,5	163	—2378	26,8	103,8	39	470	—	—	—
			ГК	XI	2577	»	1,8	12,1	—	—2506	26,9	104	135,9	517 (28)	—	221	—
			ГК	XII	2734	»	1,10	14	—	—2592	27,1	105	135,9	424 (18)	—	139	—
			ГК	XIII	2780	»	3,6	23,5	—	—2632	27,4	105	135,9	338 (20)	—	1 742	—
			ГК	XIVa	2806	»	5,8	16,4	—	—2682	28,0	106	135,9	59 (16)	—	1 271	—
			ГК	XIV6	2844	»	4,9	18,5	—	—2706	28,3	108	135,9	416 (20)	—	579	—
			ГК	XV	2914	»	6,3	19,5	—	—2773	28,7	111	135,9	537 (20)	—	1 289	—
			ГК	XVI	2934	»	5,7	19,2	—	—2810	29,1	112	135,9	306 (20)	—	1 759	—
Severnyy Naip	1974	1976													4 330	12 136	—
			ГК	Apt. III	1882	»	7,8	21,0	—	—1639	18,3	—	26,8	219—645	3 414	9 082	—
			ГК	Neoco. Va	2130	»	4,2	18,0	34	—1865	—	—	27,7	—	796	2 655	—
			ГК	V6	2200	»	2,3	18,0	—	—1991	21,0	—	27,7	—	120	399	—
Yuzhnyy Naip	1964	—													360	5 024	—
			ГК	IV6	2060	»	4	16	—	—	20,1	—	31	—	2	1 807	—
			ГК	Neoco. V	2280	»	28,4	16	—	—	—	—	31	—	358	3 217	—

Г = gas; K = condensate; and H = oil

Commas are decimals

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m³	Initial gas yield, m³/day (choke diameter)	Cumulative gas production as of 1/1/80, 10^6 m³	Gas reserves as of 1/1/80, 10^6 m³: A+B+C₁	Gas reserves as of 1/1/80, 10^6 m³: C₂
Severnoye Balkui	1975	—													75	50 082	1 885
			ГК	U. Juras. VIII	2600	Limest.	4,1	10	—	—	29,6	—	46,3	171 (16)	75	—	1 885
			ГК	X (upper)	3050	»	8,1	13	—	—2754	30,5	—	47,9	442—1630	—	14 402	—
			ГК	X (lower)	3100	»	20,2	15,7	—	—2816	30,6	—	47,9	442—1630	—	35 680	—
Gugurtli	1965	1970													27 247	81 602	4 157
			ГК	Apt. XI	1266	Sandst.	19,2	19	161	—1120	14,6	66,5	12	454 (20)	708	2 994	—
			ГК	XII (upper)	1455	»	36,9	19	161	—1342	15,6	72,5	12	314 (20)	12 671	5 967	—
			ГК	XII (lower)	1530	»	28,5	17,3	178	—1405	16,1	74	12	464 (20)	3 983	5 160	—
			ГК	Barre. XIII	1605	Limest.	13,6	13,6	17	—1491	17,8	77	12	442 (22)	1 608	264	—
			ГК	XIV	1808	Sandst.	13	17,3	122	—1701	18,6	83,5	18	359 (22)	6 769	3 793	—
			ГК	Jura. XV	1849	»	61,6	12,2	15	—1843	20,6	86	24,5	191 (20)	27	62 396	—
			ГК	XVII	2150	»	11	14,3	40	—2031	22,9	94	24,5	400 (20)	1 481	1 028	—
			ГК	XVIII	2184	»	20,6	17,4	270	—2057	23,1	94,5	24,5	509,7 (20)	—	—	4 157
Severn. Gugurtli	1969	—	ГК	XVII	1897	»	10	7	—	—2018	21,9	95	—	90 (20)	—	750	—
Beurdeshik	1971	—													—	44 855	29 907
			ГК	Cret XIV	2308	Limest.	21,8	19	83	—2144	23,5	93	28	462 (20)	—	44 855	7 093
			ГК	Jura XV_1	2398	»	4,2	13	8	—2219	24,7	94,5	30	71 (20)	—	—	—
			ГК	XV_2	2447	»	13,4	12	8	—2274	25,7	95,5	30	139 (20)	—	—	13 125
			ГК	XV_3	2548	»	0,7	16	122	—2349	26,7	97,5	30	388 (20)	—	—	—
			ГК	XVII	2780	»	7	16	2	—2650	29,4	103	28	17,3 (10)	—	—	9 689
Kirpichli	1972	1978													10 558	138 190	20 118
			ГК	Juras. X	2897	»	39,2	14	66	—2873	31,5	103	58	450—660 (16)	10 558	138 190	—
			ГК	XVII	3073	Sandst.	7	16	—	—3002	32,3	109	—	265 (20)	—	—	20 118
Sakar	1966	—	ГК	Jur. VII	2750	Limest.	4,7	12	—	—2557	28,0	105	31,5	38 (8)	—	2 580	—
Bagadzha	1971	—													—	17 028	—
			ГК	Jur. XV_I	2850	»	8	9,9	0,7—67	—2951	39,4	—	12	371 (20)	—	—	—
			ГК	XV_{II}	3360	»	13,2	8,3	0,7—67	—3018	40,1	116	12	371 (20)	—	—	—
Farab	1962	—	ГК	Callovian-Oxfordian	2340—2500	»	59	15	3—15	—2300	23,7	94	25—40	180,5 (14)	—	5 600	—
Samantepe	1964	—	ГК												—	101 374	—
				Anhydrite memb.	2304	Anhydr.	60	1,06	1,2	—2300	26,8	100,2	18	163 (25,4)	—	9 440	—
				Limest. member	2369	Limest.	33	2,66	5,3	—2300	26,8	100,2	18	512 (20)	—	7 700	—
				Limest. member	2402	»	127	5 74	53—155	—2300	26,8	100,2	18	325,4 (20)	—	84 234	—
Kishtuvan	1969	—	ГК	Callovian-Oxfordian	2510	»	67	12	—	—2478	26,0	95	—	95,7 (10)	—	2 103	—
Metedzhan	1969		ГК	Same	2730	»	118	12	—	—2476	29,2	105	—	409 (22)	—	12 067	13 600
Sundukli	1973	—	ГК	»	3461	»	53	1,86	—	—3400	61,3	135	—	50—100	—	—	—
Malay	1978	—													—	5 100	29 442
				Jura VIII	3600	»	12,6	11,0	—	—3358	38,8	119,8	8,9	676 (24)	—	3 600	8 090
				IX—X	3620	»	—	15	—	—3436	39,8	122,5	8,9	—	—	1 500	21 352
Gagarin	1978	—	ГК	X	3135—3198	»	37,4	14	—	—2965	34,0	—	15	1082	—	17 088	6 199

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, $10^6 m^3$	Gas reserves as of 1/1/80, 10^6 m^3: A+B+C_1	Gas reserves as of 1/1/80, 10^6 m^3: C_2
Stikhiy	1978	—													—	1 000	2 027
			Г	Jura. VII	2830	Limest.	8	20,5	—	—	7,9	—	—	—	—	1 000	1 670
			Г	VIII	2860	»	1,6	19,5	—	—2702	29,6	—	—	69,7	—	—	357
Shatlyk	1968	1973													157 046	465 954	352 514
			ГК	Karabil Fm.	3219	Sandst.	24	20,9	210	—3245	36,8	137	12	966 (20)	157 046	465 954	—
			ГК	Callovian-Oxfordian	3350	Limest.	—	—	—	—	—	—	—	—	—	—	352 514
Maysk	1964	1970	Г	Karabil Fm.	3018	Sandst.	30	19,7	268	—2810	32,2	124	—	1020 (22)	6 605	11 604	—
Bayram-Aliy	1961	1977	Г	same	2800	»	59	20,7	181	—2618	30,2	108	—	989 (28)	9 310	43 258	—
Yelany	1965	—	Г	»	2855	»	18	12	133	—2688	30,6	121	—	984 (28)	—	7 900	—
Keli	1965	—	Г	»	2469	»	24	12	97	—2292	26,4	100	—	876 (24)	—	1 600	—
Sharapli	1963	—	Г	»	2288	»	24	20,7	198	—2313	25,1	90	—	422 (12)	—	1 016	—
Tedzhen	1974	—	ГК	»	3900	»	9,9	18,3	—	—3750	41,1	—	14,6	580 (20)	724	16 424	—
Vostoch. Tedzhen	1978	—	ГК	»	3810	»	6,4	22,1	—	—3612	40,6	—	—	974 (16)	—	4 209	1 069
Mollaker	1976	—	ГК	»	3770	»	9,5	18,8	—	—3585	39,0	—	4,7	795 (16)	—	16 200	—
Shorkel	1978	—	ГК	»	3765	»	8,1	19,4	—	—3561	38,6	—	19,5	910 (16)	—	9 000	1 813
Uchadzhi	1978	—	Г	»	2520	»	40,8	21,1	—	—2351	25,9	—	—	559 (16)	—	46 277	—
Vostoch. Uchadzhi	1979	—	Г	Hauteriv	2560	»	16,0	20,0	—	—	27,6	—	—	—	—	6 018	1 034
Seyrab	1978	—	Г	Karabil Fm.	2530	»	58,4	21,1	—	—2351	25,9	—	—	1000 (20)	—	49 122	8 700
Islim	1963	—													—	4 400	—
			Г	Turonian	1725—1950	Limest.	80	4,6	50	—	24,4	100	—	16,7 (10)	—	700	—
			Г	Aptian-Neocom.	2197—2277	»	30	4,6	13	—	25,5	113	—	18 (10)	—	1 000	—
			Г	U. Jurassic	2304—2422	Sandst.	50	7,7	19,5	—2035	26,6	117	—	36,6 (12)	—	2 700	—
Karachop	1961	—													—	4 400	—
			Г	Danian	640—720	Limest.	20	6,2	—	—	5,8	50	—	19,7 (10)	—	900	—
			Г	Maestrichtean	784	»	70	12,3	57—151	—	6,8	52	—	169 (19)	—	3 500	—
Karabil	1971	—													—	36 090	988
			Г	Bukhara Beds	1375	»	10,2	16	—	—945	13,5	69	—	—	—	5 577	—
			Г	Hauteriv H1	2068	Sandst.	20,7	15	44	—1776	29,7	96	—	63—540	—	30 082	—
			Г	H2	2049	»	1,3	11	—	—	29,7	—	—	—	—	431	988
Beshkizy	1980	—	Г	Hauteriv	2740	»	7	18	—	—	29,2	—	—	—	—	1 513	3 478
Dauletabad-Donmez	1974	—													—	186 000	568 000
North block			ГК	»	2560	»	17,7	19,3	195—707	—3408	39,0	133,1	5,8	—	—	—	—
South block			ГК	»	3578	»	9,9	20,8	195—707	—2711	38,2	120,0	15,9	—	—	—	—
East block			ГК	»	3578	»	9,4	18,3	195—707	—2586	34,3	120,0	—	—	—	—	—

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, 10^6 m^3	Gas reserves as of 1/1/80, 10^6 m^3: A+B+C_1	Gas reserves as of 1/1/80, 10^6 m^3: C_2
Gazli	1956	1962													355 930	135 317	10 677
			Г	VII	100	Sandst.	10	15	—	—	0,8	—	—	—	—	—	35
			Г	VIII	450	»	20	15	—	—	5,3	—	—	—	—	—	412
			Г	VIIIa	475	»	40	10	—	—355	5,5	47	—	—	—	—	10 230
			Г	VIIIб	600	»	15	10	—	—500	7,0	50	—	—	—	6 400	—
			Г	IX	680	»	100	20	1457	—533	7,0	50	—	450	168 082	56 558	—
			Г	X	800	»	74	19,7	1169	—626	8,1	55	—	400	103 384	18 001	—
			ГК	XI	870	»	10	14	331	—728	9,0	57	7,7	200	1 546	7 974	—
			ГК	XIa	960	»	5,5	15	443	—865	9,8	59	11	—	12	14 674	—
			ГК	XII+XIII	1050	»	40	23	859	—906	11,0	60	15	500	80 306	25 694	—
			ГК	XIII	1080	»	—	—	674	—932	11,2	61	15	500	2 600	6 016	—
Yangikazgan	1963	1973													3 716	1 909	—
			Г	XII	1200	»	6,8	20	153—204	—1043	12,2	67,5	34	700	2 396	1 066	—
			Г	XIII₂	1362	»	3,6	19	11—62	—1208	13,6	73	34	133	—	292	—
			Г	XIV	1450	»	2,6	18	71—460	—1287	14,4	75,5	34	442	1 280	551	—
			Г	XV	1562	Limest.	7,9	20	1—60	—1300	14,5	76	34	273 (10)	40	—	—
Tashkuduk	1953	1972													654	1 536	—
			Г	VII	280	Sandst.	4,5	26	580	—78	2,7	25	—	60 (6)	—	106	—
			Г	IX	530	»	4,6	2,7	10—1420	—358	5,3	37	—	238 (19)	654	1 430	—
Dzharkak	1955	1958													6 383	1 390	—
			Г	XII	880	»	12,7	16,9	182—1700	—590	9,0	50,8	—	466 (6)	5 553	827	—
			ГН	XIII	980	»	11,6	13,3	24—171	—595	8,9	51,3	—	—	830	445	—
			ГН	XV	1200	Limest.	18	4	25	—865	11,2	52	—	58 (19)	—	118	—
Setalantepe	1956	1976													73	414	—
			Г	XI	560	Sandst.	8	11	До 300	—300	5,6	36	—	218	—	9	—
			Г	XII	830	»	13,5	12	43—1050	—466	8,2	40	—	60	36	364	—
			Г	XVI	1000	Limest.	3	15	50—320	—750	10,7	48	—	122 (26)	30	41	—
			Г	XVII	1050	Sandst.	3,6	15	320—460	—750	10,3	50	—	102	7	—	—
Karaulbazar-Sarytash	1975	1966													597	4 431	59
			Г	XII	960	»	2,2	15,9	70—115	—636	9,3	47	—	90 (20)	76	412	21
			ГН	XIII	1020	»	2,6	15	200—783	—675	10,1	48	—	450	182	454	—
			ГН	XV	1200	Limest.	15	5	1—17	—940	12,4	52	53	227	339	3 565	38
Yulduzkak	1960	1968													150	393	—
			Г	XII	800—840	Sandst.	15,6	19	480	—593	9,0	54	—	346 (25)	94	—	—
			Г	XIII	850—890	»	16	12	440	—618	9,4	55	—	375 (28)	56	22	—
			Г	XV	1080—1190	Limest.	9,8	6	20—28	—794	12,5	59	—	115 (22)	—	251	—
			Г	XVI	1080—1185	»	18	12	90	—992	12,7	60	—	—	—	86	—
			Г	XVII	1220—1285	Sandst.	3,1	14	140	—1010	13,0	62,5	—	337 (22)	—	34	—
Zapadnyy Yulduzkak	1969	1971	Н	XIII	900	»	6,1	16,7	18	—	10,6	—	—	—	—	—	—
			ГН	XV	1200	Limest.	0,5	3,9	20—28	—	12,4	—	—	—	8	62	—
Mamadzhurgaty	1958	—													—	—	—
			Г	XII	950—1000	Sandst.	—	14	70—925	—	9,4	47	—	90 (20)	—	—	—
			Г	XV	1220—1350	Limest.	—	1—3	927	—990	13,0	—	—	2,4	—	—	—
Akdzhar	1959	1965													800	1 118	26
			Г	IX	253	Sandst.	31,3	23	339	—10	3,0	34,6	—	167	—	74	—
			Г	XII	550	»	5,5	23	137	—372	5,8	45,2	—	430	323	456	—
			Г	XIII	585	»	17,6	18	163	—388	6,8	46	—	580	477	454	—
			Г	XIV	670—717	»	5,7	16	189	—396	6,9	47	—	373	—	60	—
			ГН	XV	729—768	»	2,6	18	98	—478	7,6	50	—	155	—	74	26
			Н	XVI	800	»	—	—	128	—495	7,9	50,8	—	—	—	—	—

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, $10^6 m^3$	Gas reserves as of 1/1/80, 10^6 m^3: A+B+C_1	C_2
Surchi	1959	1964													1 421	497	42
			Г	XII	560—650	Sandst.	7,8	24,6	49—160	—381	6,1	46	—	300	831	130	—
			Г	XIII	600—850	»	9,5	18,2	15	—398	6,7	47	—	475	590	112	27
			ГН	XV	690—870	Limest.	2	18	25	—490	7,5	49	—	106	—	111	15
			ГН	XVI	740—890	Sandst.	4,2	18	150	—487	7,5	50	—	78	—	115	—
			ГН	XVII	780—850	»	18	12	208	—490	7,5	50	—	280	—	29	—
Shurtepe	1960	1966													1 260	1 044	—
			ГК	XII	1230—1500	»	8,2	18,8	162	—1016	13,2	65,6	13,7	275 (15)	1 260	264	—
			ГН	XIII	1285—1500	»	1,9	16	123	—1029	13,5	66,7	—	543 (16)	—	780	—
Yuzhnyy Murabek	1958	1964													21 918	3 089	—
			ГК	XI	1050	»	—	—	—	—	—	—	—	—	30	170	—
			ГК	XII	1160—1470	»	17,1	22	125—578	—976	12,7	66	51,1	530 (15)	13 444	391	—
			ГК	XIII	1230—1450	»	12,8	21	24—938	—995	13,1	69	65,5	340 (15)	5 801	149	—
			ГК	XVa	1650	Limest.	12,3	16	—	—	17,3	—	53	—	1 652	1 148	—
			ГК	XVIII	1930	Sandst.	15	14	—	—	—	—	53	190—525	991	1 231	—
Severnyy Mubarek	1960	1961													22 463	3 662	—
			ГКН	XV+XVa	1795—2190	Limest.	44	14	94	—1604	19,6	75	51	302 (11)	14 228	3 327	—
			ГК	XVIII	2080—2400	Sandst.	12,8	14	57	—1914	22,8	85	60	483 (11)	8 235	335	—
Khodzhikhayram	1959	1978													122	967	—
			Г	XVa	1700—1800	Limest.	6,5	19,6	20—32	—1387	17,5	77	8—20	331 (15)	26	563	—
			Г	XVII	1940—1952	Sandst.	—	—	—	—1647	19,2	—	—	892 (24,8)	96	404	—
Kyzylrabat	1960	—	Г	XVa	1400	Limest.	17,9	3,2	60	—1092	13,9	67	—	22	—	1 774	—
Karabil	1960	1971													2 715	324	—
			Г	XII	1045	Sandst.	13,8	21,8	6—335	—788	11,3	—	1,5	267 (16)	2 715	324	—
			ГН	XIII	1125	»	18	10,9	360	—808	11,2	—	—	171	—	—	—
			Н	XV	1125	Limest.	2,4	8,2	—	—	14,1	—	—	—	—	—	—
Karaktay	1961	1967													815	159	—
			Г	XII	411—567	Sandst.	11,1	19	30	—166	5,2	47	—	525 (10)	357	—	—
			Г	XIII	447—629	»	23,3	19,3	120	—188	5,2	48	—	252 (12,6)	458	159	—
			Н	XV, XVa, XVI	800	Limest.	47	1,5	40—83	—	7,8	—	—	—	—	—	—
Vostochnoye Tashli	1963	—	ГК	XVa+XVI	1460—1530	»	17,9	5,8	1—3	—1088,5	14,7	72	—	211	—	757	—
Karakum	1967	1975													4 258	4 671	—
			ГК	XV	2000—2040	»	5,3	18,8	10—197	—1755	20,6	87	70	188 (9)	—	1 582	—
			ГК	XVa	2060—2150	»	23,1	18,8	10—197	—1755	21,2	87	70	457 (12)	4 258	3 089	—
Sarycha	1967	—	Г	XII+XIII	1050—1090	Sandst.	10,5	16,6	22—90	—670	10,4	—	—	199 (12)	—	770	—
Karim	1966	1973													1 277	2 269	—
			ГК	XV	2100	Limest.	12,6	3,6	1—16	—1872	21,7	91	142	210 (10)	—	733	—
			ГК	XVa	2115	»	8,8	17,6	1—85	—1872	21,7	91	142	420 (13)	1 277	1 536	—
Kultak	1963	—													2 314	30 428	6 011
			ГК	XVa$_1$	2900—3200	»	26	11	0,1—3,4	—2740	54,3	105	54,6	32,3—83,7	2 314	18 892	—
			ГК	XVa$_2$	2900—3200	»	19	11	0,1—3,4	—2740	54,3	105	54,6	32,3—83,7	—	11 536	6 011
Adamtash	1962	—													—	30 701	—
			ГК	XV	1107—1710	»	110	3,15	65—145	—510	17,1	61,0	165	402 (15)	—	18 119	—
			ГК	XVa	1283—1710	»	80	11,6	1—977	—510	17,4	62,5	165	327 (15)	—	12 582	—
Gumbulak	1968	—	ГК	XV+XVa	2300—2500	»	36—88	9,6—16	До 1	—1690	28,0	90	77	77 (15)	—	31 892	—
Kamashi	1970	—	ГК	XV+XVa	3260	»	9,1	5,5	—	—2976	54,3	105	166	433 (35)	—	960	—
Shumak	1973	1976													37	774	—
			ГК	XVa	1770	»	4,3	15	—	—	—	—	—	144 (10)	—	93	—
			ГК	XVIII	2010	Sandst.	11	16	—	—	20,0	—	—	400 (12)	37	681	—
Zevardy	1968	—													2 439	185 961	—
			ГК	XV$_{нр}$	2597	Limest.	27	14	—	—2610	49,2	108	76	—	—	38 280	—
			ГК	XV$_{р}$	2650	»	86	17	—	—2610	49,2	108	76	—	2 439	147 681	—
Uvady	1966	—	Г	XII—XIII	730	Sandst.	13	16,6	60	—	6,4	—	—	206 (25)	—	549	—

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, 10^6 m^3	Gas reserves as of 1/1/80, 10^6 m^3: A+B+C_1	C_2
Kandym	1966	—				Limestone									—	152 843	6 069
			ГК	XV$_1$	2050		7,3	15	0—234	—	22,6	—	29	51,2 (11)	—	78 331	3 197
			ГК	XV$_2$	2100	»	8,4	16	48	—	22,6	—	29	572 (15,4)	—	74 512	2 872
Dengizkul-Khauzak-Shady	1966	—	ГК	XV$_p$+XV$_{np}$	2316—2378	»	18	15	6—168	—	26,0	100	27	450 (22)	—	118 059	6 757
Urtabulak	1963	1973	ГКН	XV	2185	»	72	16	0,1—80	—2322	26,2	96	17,8	480 (21,8)	15 809	86 791	—
Uchkyr	1960	1968													20 501	23 946	—
			ГК	XII	1280	Sandst.	15	22	—	—1000	12,3	64	19,5	—	696	504	—
			ГК	XIV$_1$	1600	»	6,9	16,4	1—125	—1478	16,7	71	18	486 (22,7)	16 890	6 687	—
			ГК	XIV$_{1a}$	1640	»	0,6	16,9	27	—1490	16,9	71	18	306 (22)	1 399	—	—
			ГК	XIV$_2$	1650	»	2,7	11	87	—1490	16,9	73	18	380 (18)	1 511	466	—
			ГНК	XV$_1$	1690	Dolomite	18,3	16	16	—1525	17,2	74	27	320 (16)	5	12 215	—
			ГК	XV$_2$	1700	Limest.	5,5	16	7,3	—1515	17,2	76	33,7	160,5 (18)	—	2 574	—
			ГК	XVI	1830	»	15	15	—	—	18,3	—	33,7	212 (18)	—	1 500	—
Kul'beshkak	1964	—													—	7 401	4 320
			ГК	XV$_1$	1794	»	4	14,7	43—188	—1667	19,0	78,8	32	—	—	1 290	4 320
			ГК	XV$_2$	1830	»	4,9	13	41—295	—1705	19,0	80,1	32	27,2 (15)	—	6 111	—
Akkum	1966	—													—	10 711	—
			ГК	XV$_1$	2080	»	9	16	6	—1909	20,6	—	61	130	—	10 094	—
			ГК	XV$_2$	2170	»	8	15	12,6	—1948	20,9	—	61	84	—	617	—
Dayakhatyn	1966	—													—	12 200	—
			ГК	XV$_1$	1832—1976	»	7	18	21,9	—1763	19,2	78	30	157	—	5 000	—
			ГК	XV$_{2a}$	1856	»	13,3	14	31,7	—1800	19,5	80,5	30	7,9	—	7 200	—
			ГК	XV$_{2б}$	1879	»	13,0	14	31,7	—1800	19,5	80,5	30	446	—	—	—
			ГК	XV$_{2в}$	1912	»	6,4	13	31,7	—1800	19,5	80,5	30	10,7	—	—	—
			ГК	XVIII	2260	Sandst.	4,2	13,6	—	—1874	23,1	—	30	327,6	—	—	—
Kuanysh	1966	—	ГК	T$_2$	3220	»	14	8,6	—	—3138	36,2	—	400	128 (24)	—	1 848	—
Parsankul	1969	—	ГК												—	7 428	—
			ГК	XV$_1$	2050	Limest.	9	16	63—75	—	20,6	—	37	21	—	5 725	—
			ГК	XV$_2$	2100	»	5,5	13	13	—1912	21,1	—	37,1	224	—	1 521	—
			ГК	XV$_3$	2180	»	2,4	13	—	—2049	22,0	—	74,8	293	—	182	—
Shakhpakhty	1963	1971													313	40	—
			Г	U. Jura Ia	1611—1693	Sandst.	3,8	10	—	—	16,1	78,6	—	—	313	40	—
			Г	U. Jura I	1636—1755	»	8,3	18	10—700	—1545	16,2	78,6	—	165 (9)	6 190	7 467	—
			Г	II	1724—1764	»	9,4	18	109—312	—1597	17,1	80,6	4,4	135 (9)	12 379	5 405	—
			Г	III	1772	»	4,7	19,4	2—718	—1662	17,5	84	—	158 (9)	3 743	3 358	—
			Г	IIIa	1810	»	5,9	19,4	14—176	—1676	18,2	86	—	160 (9)	357	1 158	—
			Г	IV	1860	»	2	11	—	—1726	18,3	88	—	100 (9)	757	2 321	—
			Г	VIII	2216	»	9,1	16	2—100	—2026	21,5	102,6	—	165 (9)	149	3 309	—
			Г	VIIIa	2226	»	5,1	16	3—28	—2083	22,3	105	—	222 (9)	—	—	—
Lyal-Mikar	1943	1947													350	1 257	—
			ГН	Bukhara I	895	Limest.	3,5	19	1,6	—	9,3	—	—	90	187	1	—
			ГН	II	885—1090	Dolomite	26	19	0,06	—	12,7	—	—	1775	—	—	—
			ГН	III	935—1115	Limest.	6	21,7	1,11	—	9,5	—	—	55	—	—	—
			ГН	IV	956—1075	»	10	12	15,1	—	12,7	—	—	1536	—	—	—
			Н	V	990—1130	»	5,8	17,1	—	—	9,5	—	—	—	—	—	—
			Н	Akdzhar., VI	1190	»	4	17	0,2	—	12,7	—	—	—	—	—	—
			ГК	Senon VII, VIII, IX	1252—1301	Sandst.	—	10	—	—	13,7	—	—	378	163	1 256	—
Gadzhak	1974	—													—	16 000	26 640
			Г	L. Cretaceous	2440	»	—	—	—	—	37,0	—	—	67 (15)	—	1 000	26 640
			ГК	XV	3300	Limest.	75	3,3	—	—	67,4	132	—	3000 (12)	—	15 000	—
Shurtan	1974	—	ГК	XV$_{np}$+XV$_p$+XV$_{np}$	3000	»	46—100	13	—	—2680	35,5	113	58	660—820 (18)	—	370 290	177 300
Pachkamar	1974	—	ГК	XVa, XV	2080	»	27	8,4	—	—	21,7	—	90	262 (—4)	—	320	4 640
Alan	1977	—	ГК	XV$_{np}$+XV$_p$	2650	»	17,8	8,4	—	—2750	56,0		60		353	2 247	67 170
Amanata	1976	—	Г	XVa	620—800	»	32	9	—	—	15,4	—	42	130 (10,5)	—	100	1 375

Table 2 continued

Field	Year of discovery	Year onstream	Pool	Producing horizon	Depth, m	Reservoir	Effective thickness, m	Porosity, %	Permeability 10^{-5} m^2	Initial gas (oil) water contact	Initial fm. pressure, mpa	Formation temperature, °C	Condensate content, g/m^3	Initial gas yield, m^3/day (choke diameter)	Cumulative gas production as of 1/1/80, 10^6 m^3	Gas reserves as of 1/1/80, 10^6 m^3 A+B+C_1	C_2
Umid	1976	—	НГК	XV	2600	Limest.	27,7	12	—	—	26,2	—	64,8	705 (23)	—	630	6 140
Pirnazar	1977	—	ГК	XV$_{нр}$	2600	»	17,8	8,4	—	—2379	27,0	—	42	—	—	117	552
Markov	1978	—	ГК	XV$_{нр}$	2700	»	30	10	—	—2441	27,3	—	40	265 (9)	—	111	4 860
Sardob	1979	—	ГК	XV	2710	»	3	20	—	—	35,2	—	65	533 (18)	—	98	143
Severnyy Maymanak	1979	—	ГК	XVIII	2440	Sandst.	7,2	15	—	—2125	24,7	—	49	325,6 (12)	—	110	2 440
Khodzhikazgan	1970	—													—	6 899	1 003
			ГК	XV$_{-1}$	1850	Limest.	5,7	10	—	—1716	19,2	—	33	62—430	—	418	—
			ГК	XV$_{-2}$	1910	»	10	13	—	—1791	19,5	—	29	62—430	—	2 925	—
			ГК	XV$_{-3}$	2030	»	5,4	10	—	—1855	20,6	—	36	—	—	—	239
			ГК	XVI	2170	Sandst.	5,8	10	—	—2011	22,2		34	—	—	556	—
			ГК	XVIII	2380	»	20,4	10	—	—2305	24,2	—	58	—	—	3 000	764
Alat	1973	—													—	2 462	—
			ГК	XIV	1960	»	2,1	10	—	—1768	20,2	—	18	117 (11)	—	286	—
			ГК	XV$_{-2}$	2240	Limest.	4,7	14	—	—2058	23,5	—	18	130 (13)	—	2 176	—
Tegermen	1976	—	ГК	XV$_{-2}$	2400	»	5,7	10	—	—	23,5	171 (15)	13	—	—	100	710
Severnyy Dengizkul	1975	—	ГК	XV$_{-р}$+XV$_{-мр}$	2600	»	15	10,7	—	—2332	26,1	—	21,6	181—486	—	8 860	7 340
Chandyr	1976	—	ГК	XV$_{-мр}$	2000	»	8,6	10	—	—1926	21,3	103—250	35	—	—	2 200	5 720
Uzunshor	1974	—	ГК	XV	2700	»	5,7	11	—	—2263,7	25,2	—	29	—	—	974	430
Yuzhn. Kemachi	1979	—	НГК	XV	2320	»	33,6	8,7	—	—2061	23,4	—	33	136 (4)	—	149	33 190
Khodzhi	1969	—													—	1 332	628
			ГК	XV$_{-16}$	2156	»	5,4	15	—	—1977	21,7	—	28	—	—	803	361
			ГК	XV$^{2+3}_{-2}$	2216	»	3,9	16	—	—2027	21,6	—	28	—	—	529	267
			ГК	XV$_{-16}$	2155	»	3,9	15	—	—1987	21,7	—	28	—	—	—	—
			ГК	XV$^{2+3}_{-2}$	2214	»	5,2	16	—	—2033	21,6	—	28	—	—	—	—
Zapadnyy Khodzhi	1978	—	ГК	Upper Jurassic	2200	Sandst.	9	12	—	—2014	21,9	—	28	212 (15)	—	230	4 470
Pamyk	1965	—															
Central crest			НГК	XV$_{р}$+XV$_{нр}$	2800	Limestone	15	12	—	—2500	—	—	68	11—435	—	61 851	5 484
South crest			НГК	XV$_{мр}$	2683	»	85	16	—	—2644	—	—	85,7	914—2000	—	2 238	—
North crest			ГН	XV$_{мр}$	2700	»	3,8	12	—	—2477	—	—	—	38 (10)	—	59 563	5 484
Beshkent	1974	—	ГК	XV+XVa	3280	»	39	5,5	—	—2947	54,4	—	209	977 (18)	—	5 322	—

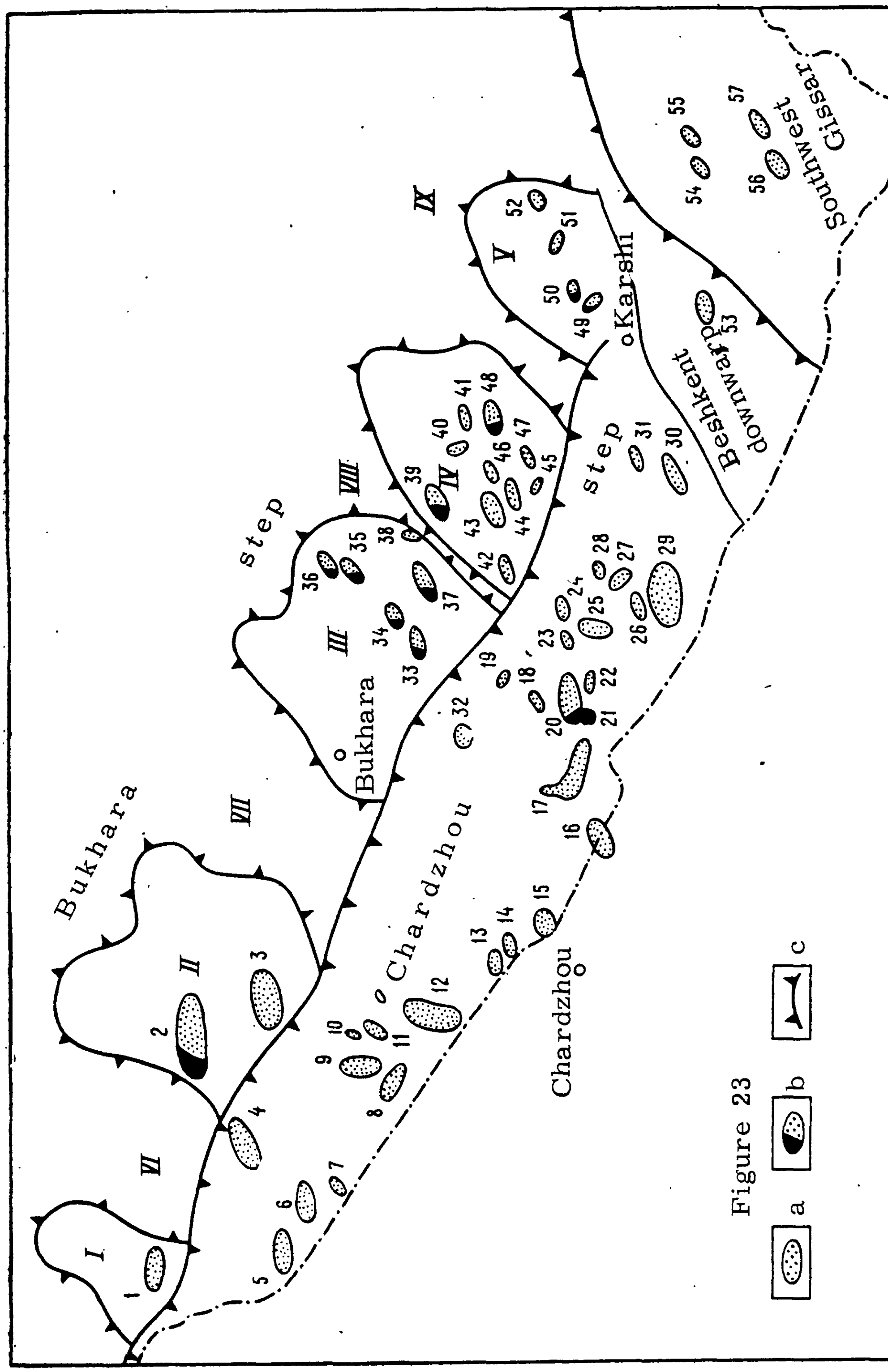

Bukhara step
Chardzhou step
Bukhara
Chardzhou
Karshi
Beshkent downwarp
Southwest Gissar
I
II
III
IV
V
VI
VII
VIII
IX
a
b
c
Figure 23

Figure 23.--Distribution of oil and gas fields of western Uzbekistan (from Zhabrev, 1983).

a - Gas and gas-condensate fields, b - gas-oil fields, c - boundaries of main tectonic elements. Highs: I -Yangikazgan, II - Gazli, III - Kagan, IV - Mubarek, V - Tashlin. Downwarps: VI - Tuzkoy, VII - Rometan, VIII - Yambashkin, IX - Pulaty-Kokdalin.

Fields: 1 - Yangikazgan, 2 - Gazli, 3 - Tashkuduk, 4 - Uchkyr, 5 - Dayakhatyn, 6 - Kul´beshkak, 7 - Khodzhikazgan, 8 - Parsankul, 9 - Akkum, 10 - Zapadnyy Khodzhi, 11 - Khodzhi, 12 - Kandym, 13 - Alat, 14 - Tegermen, 15 - Uzunshor, 16 - Samantepe, 17 - Severnyy Dengizkul, 18 - Umid, 19 - Yuzhnoye Kemachi, 20 - Urtabulak, 21 - Severnyy Urtabulak [20 and 21 appear to be reversed], 22 - Sardob, 23 - Markov, 24 - Piriazar, 25 - Zevardy, 26 - Alan, 27 - Yuzhnyy Pamuk, 28 - Severnyy Pamuk, 29 - Kultak, 30 - Kamashi, 31 - Bashkent, 32 - Chandyr, 33 - Karaulbazar, 34 - Dzharkak, 35 - Akdzhar, 36 - Shurchi, 37 - Yulduzkak, 38 - Setalantepe, 39 - Shurtepe, 40 - Shumak, 41 - Kazylrabat, 42 - Karim, 43 - Severnyy Mubarek, 44 - Yuzhnyy Mubarek, 45 - Severnyy Mubarek, 46 - Khodzhikhayram, 47 - Karakum 48 - Karabair, 49 - Karaktay, 50 - Vostochnoye Tashly, 51 - Sarycha, 52 - Uvady, 53 - Shurtan, 54 - Pachkamar, 55 - Amanata, 56 - Gumbulak, 57 - Adamtash.

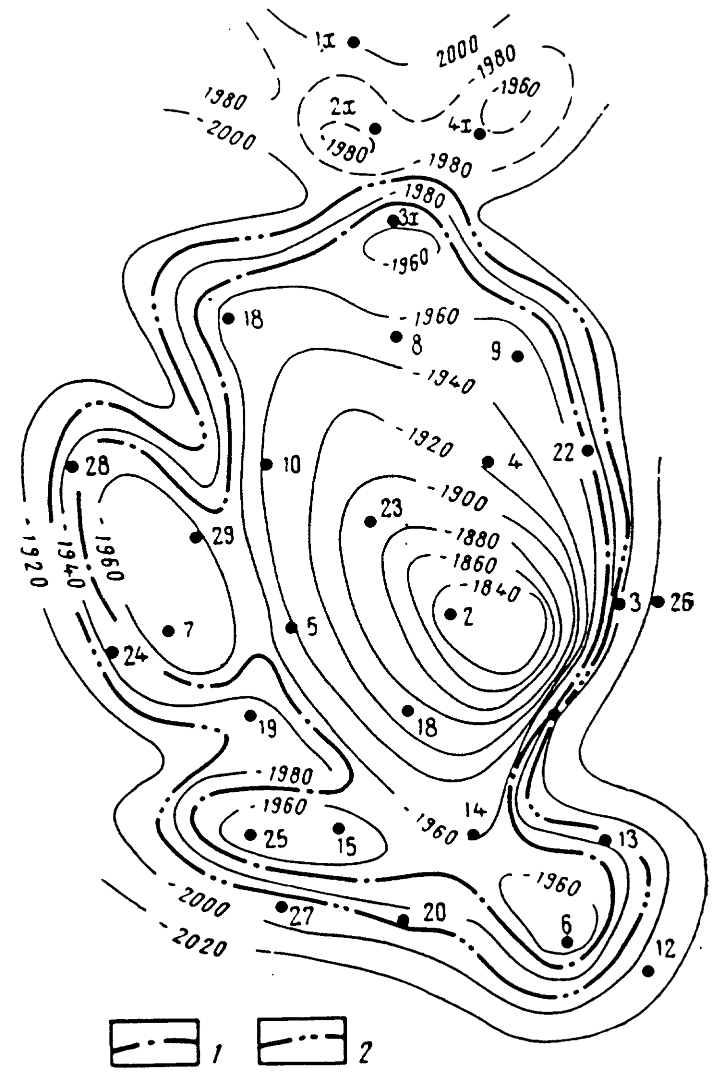


Figure 24.--Structure map of Kandym gas-condensate field on top of horizon XV_{1b} of the Upper Jurassic (from Zhabrev, 1983).

1 - Inner margin of gas pool; 2 - outer margin.

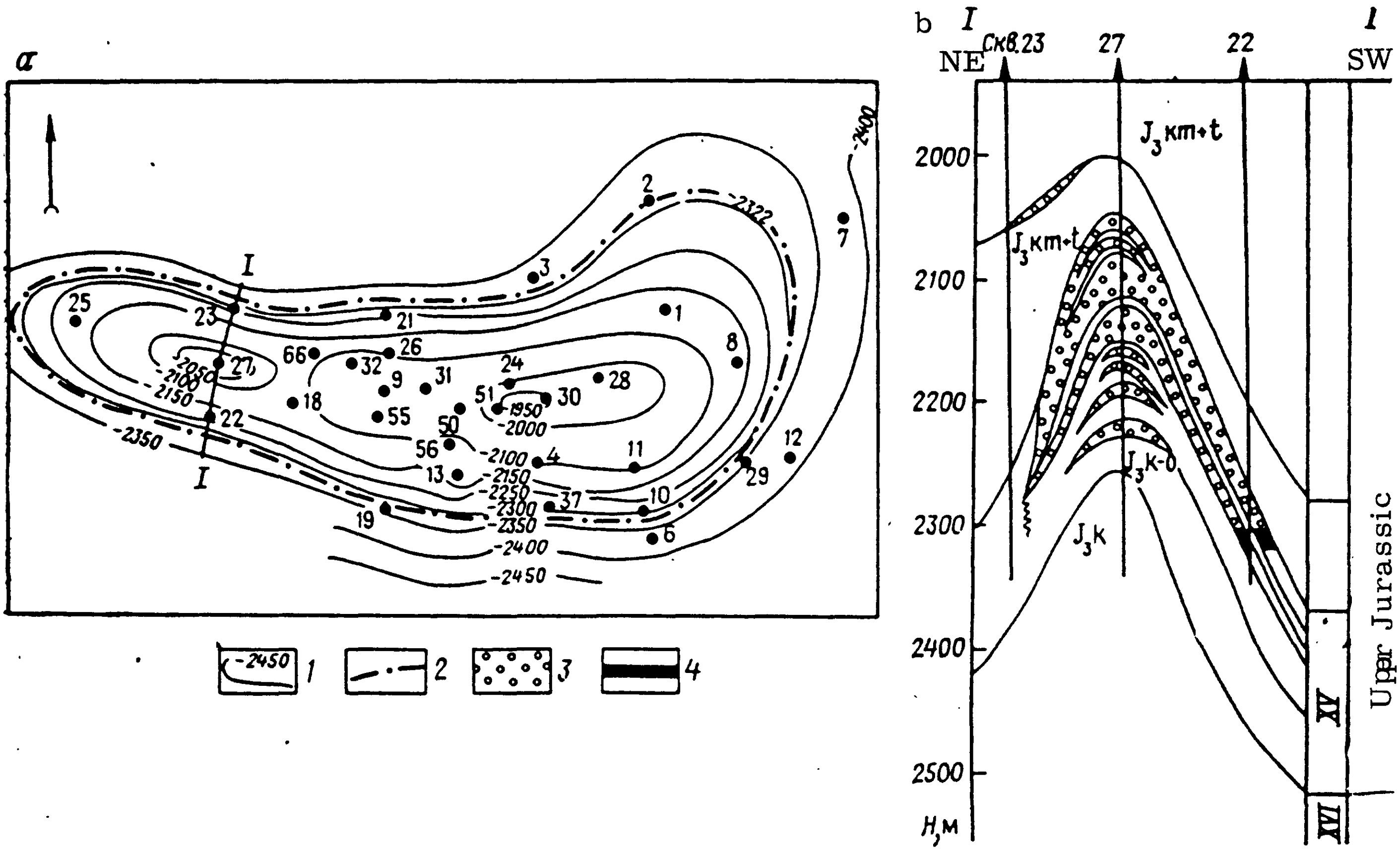


Figure 25.--Urtabulak gas-condensate field (from Zhabrev, 1983).

a - Structure map on the top of horizon XV of the Upper Jurassic; b - geologic section. 1 - Structure contours, m; 2 - margin of gas pool; 3 - gas; 4 - oil.

The Kultak gas area (fig. 16 and D,d in fig. 2) encloses all the pools at the southeast end of the Chardzhou step (24 to 30 in fig. 18). Although the Kultak gas-condensate field is very large on the map, its reserves are only about 1 tcf. Its dimensions are 23 by 16 km and closure is 210 m. The reservoir rock here is Upper Jurassic limestone (fig. 26).

Note the discrepancy between field size and distribution as shown in figs. 2 and 23.

The Beshkent gas area (fig. 16 and D,e in fig. 2) coincides with the Beshkent downwarp. This area has not been studied extensively, and only two fields have been discovered, the Beshkent and Shurtan. In the Shurtan field a gas-condensate pool occurs in a Callovian-Oxfordian reef limestone sealed by salt and anhydrite of Kimmeridgean-Tithonian age (fig. 27). Reserves are 13 tcf, and inferred reserves are estimated at 6 tcf.

The Bukhara gas-oil region (fig. 16 and E of fig. 2) coincides with the Bukhara step of the northeast border of the Amu-Dar'ya gas-oil province. Within this region are the Gazli gas area and the Kagan-Mubarek gas-oil area. Most of the region is not favorable, however, because the sedimentary section is thin.

The Gazli gas area (fig. 16 and E,a in fig. 2) includes the Gazli and Tashkuduk fields. Gazli has been in production since 1962 and by 1980 had yielded more than 12 tcf. Remaining reserves are 5 tcf. The largest pools are in horizons IX, X, and XII of Albian and Cenomanian age (fig. 28). Severe earthquakes at Gazli have been attributed to production activity in the field.

In the Kagan-Mubarek gas-oil area (fig. 16 and E,b in fig. 2), the productive horizons have a great stratigraphic range including Middle and Upper Jurassic and Lower and Upper Cretaceous. Eight pay zones are present. Most of the pools are gas, and oil occurs as rings. The Jurassic reservoirs are largely carbonate sediments, and the Cretaceous are sandstones.

The Murgab gas region (fig. 16 and F of fig. 2) is by far the largest of the regions of the Amu-Dar'ya gas-oil province. It has an area of 90,000 km^2 and includes the Shatlyk, Bayram-Ali, and Uchadzhi gas areas.

The Shatlyk gas area (fig. 16 and F,a in fig. 2) has two fields, Shatlyk and Tedzhen, both of which are on arches. The gas pool in Shatlyk field is in Lower Cretaceous sandstones (fig. 25). More than 5 tcf have been produced and 16 tcf reserves remain. The inferred reserves in the Callovian-Oxfordian limestone play in this field are assessed at 12 tcf.

The Bayram-Ali gas area (fig. 16 and F,b in fig. 2) contains the Bayram-Ali and May gas fields. Both are in Lower Cretaceous sandstones. Bayram-Ali has reserves of 1.4 tcf, and May has 0.4 tcf.

The Uchadzhi gas area (fig. 16 and F,c in fig. 2) has two gas fields, the Uchadzhi and Seyrab. Their gas pools are in Lower Cretaceous sandstones.

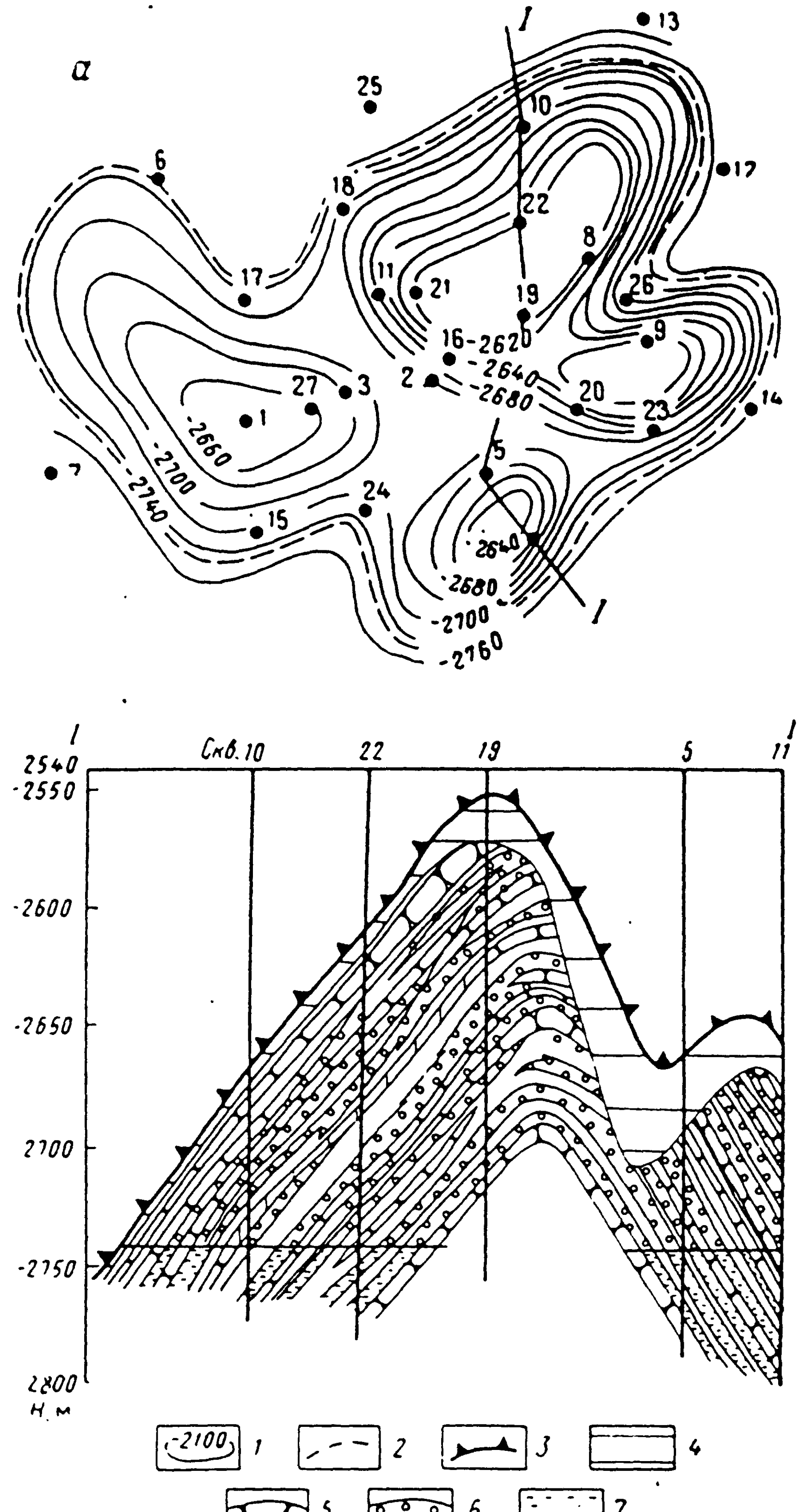
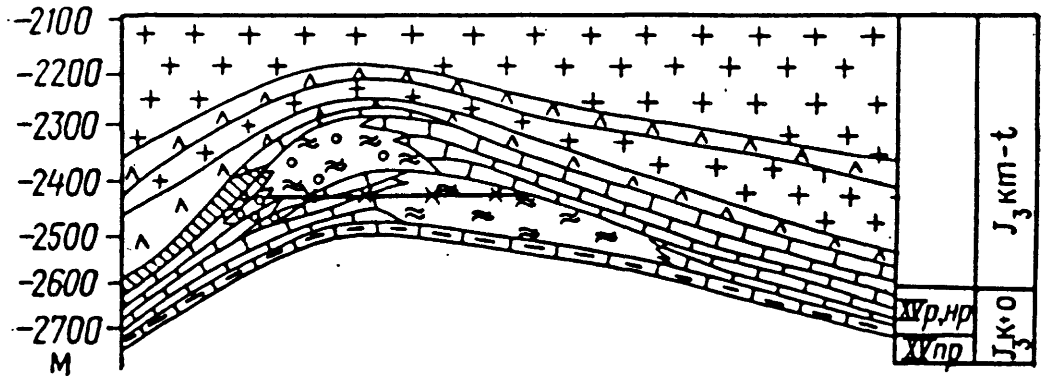


Figure 26.--Kultak gas-condensate field.

a - Structure map on the Upper Jurassic carbonates, b - probable configuration of the gas pool.

1 - Structure contours, m; 2 - margin of gas pool; 3 - Kimmeridgean-Tithonian anhydrites (main seal); 4 - high-gamma rock (upper productive noncommercial [sic] zone); 5 - impermeable beds; 6 - gas; 7 - water.

Shurtan



Shatlyk

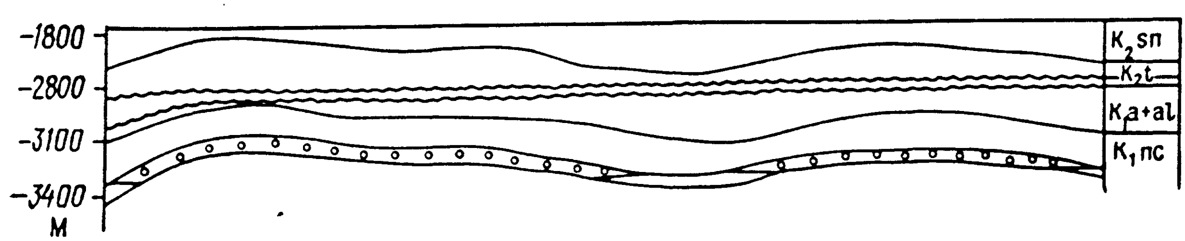


Figure 27.--Shurtan and Shatlyk gas-condensate field (from Dikenshteyn, 1983).

1 - Salt; 2 - anhydrite; 3 - limestone, clayey limestone; 4 - reef buildup; 5 - shale; 6 - gas; 7 - gas-water contact.

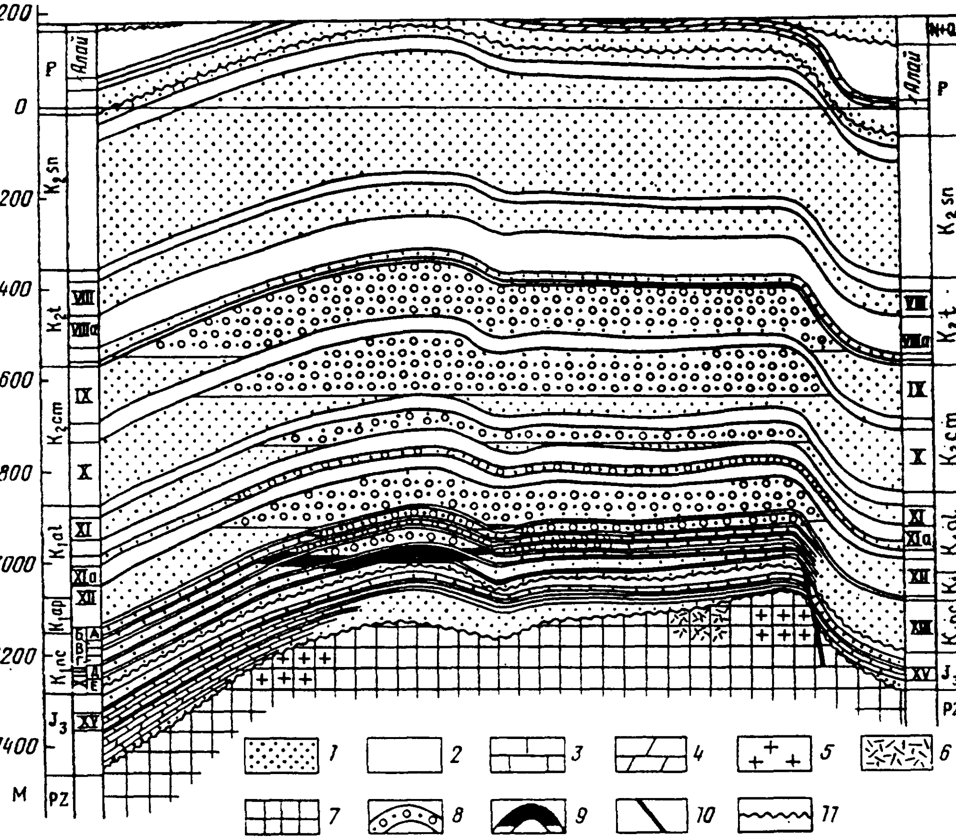


Figure 28.--Gazli gas field (from Bakirov, 1979).

1 - Sand-silt sediments; 2 - clay sediments; 3 - limestone; 4 - marl; 5 - granite; 6 - silicic volcanics; 7 - Paleozoic basement; 8 - gas pools; 9 - oil pools; 10 - faults; 11 - erosion surface.

The Badkhyz-Karabil gas region (fig. 16 and G of fig. 2) in the south of the study area contains the Dauletabad, Karabil, and Kushka gas areas. Since this region is on the margin of the Amu-Dar'ya regional low, the sedimentary section is not thick, ranging from 2 to 3 km.

In the Dauletabad gas area (fig. 16 and G,a in fig. 2) is the giant Dauletabad-Donmez (Stalinabad) gas field. The pool is in Lower Cretaceous red sandstone (Mirzakhanov and others, 1975). Proved reserves and predicted resources were 26 tcf in 1980; however, recent reports have placed this much higher. Reserves per completed well were given by A. A. Trofimuk in 1983 as 0.9 tcf (Izvestia, Sept. 13). Also, an oil discovery beneath the gas pools has now been reported (Oil and Gas Journal, Aug. 30, 1982). The gas is dry, containing less than 18 g/m^3 of condensate, and sometimes none (Amurskiy and others, 1984).

The Karabil gas area (fig. 16 and G,b in fig. 2) has one gas field, the Karabil. Pools are present in sandstones of the Lower Cretaceous and carbonate-clastic sediments of the Paleogene. Total reserves are 1.2 tcf.

The Kushka gas area (fig. 16 and G,c in fig. 2) contains the Karachop and Islim gas fields. The pools occur in sandstones of the Upper Jurassic and Lower and Upper Cretaceous.

Petroleum genesis

Two types of oil are found in the Amu-Dar'ya province in the Middle and Upper Jurassic and Lower Cretaceous sedimentary rocks (Chetverikova and others, 1982). Type I oils occur in the northwest and have a low density at 0.820-0.860. Type II oils are found in the southeast, and they have a density of 0.860-0.950. The sulfur isotopes of the hydrocarbons of the northwest are on the heavier side, indicating continental deposition, whereas on the southeast they are lighter, indicating marine deposition. The organic matter in the rocks is compatible with this environment of deposition: it is humic on the northwest and sapropelic on the southeast. The northwest region is gas-prone, whereas in the southeast both oil and gas pools are present.

The high quality of the Lower and Middle Jurassic source beds is attributable to the humid climate at their time of deposition. In Late Jurassic time the climate became arid, and the source-bed quality decreased.

The oil-gas plays of the Amu-Dar'ya province are the same as those of the Arabian-Iranian basin (Yermolkin and others, 1983). The fact that Amu-Dar'ya is gas-prone and the Arabian-Iranian basin is oil-prone is explained by a difference in tectonism.

In the Arabian-Iranian basin the zones of intensive downwarping in the Jurassic, Cretaceous, and Paleogene did not coincide in space. They migrated successively eastward toward the Zagros. The source beds in each of these downwarps entered the oil window, and consequently, the region is oil-prone.

Conditions were different in the Amu-Dar'ya region. Downwarping took place in essentially the same place during the entire time, and the source beds subsided into the high temperature zone of the gas window. Consequently, this region is, in general, gas-prone.

In addition to the humic organic matter and entry of source beds into the gas window, the gas prone nature of the Amu-Dar'ya province may have been favored by yet another factor. The Kimmeridgean salt seal was deposited directly on carbonate reservoir rocks at a time when the source beds were still in the upper, biogenic gas window. The pore space may have become filled by this early gas, thus rendering the reservoir rocks incapable of absorbing oil. Consequently, most of the oil simply was dissipated into the rock without being trapped. Any oil that did collect was subsequently displaced from traps by the later thermal gas.

Potential of Province

The Amu-Dar'ya province still has great potential for new discoveries, particularly for gas. The main directions for exploration given by Dikenshteyn (1983) are:

1. Continued exploration of the sub-salt Upper Jurassic primarily in zones of high-porosity reefs on the Chardzhou structural step and in the Beshkent downwarp.

2. Search for sulfur-free gas in Cretaceous and Jurassic sediments on the margins of the Amu-Dar'ya regional low in the Shatlyk, Beurdeshik, Dauletabad, and other areas.

3. Exploration of the Lower and Middle Jurassic clastic sediments of the Amu-Dar'ya regional low.

4. Assessment of the oil-gas potential of the Jurassic and Cretaceous sediments of the Cis-Kopet Dag foredeep and Bakhardok flank.

5. Search for stratigraphic traps in zones of pinchout of Cretaceous and Jurassic sediments on the Bukhara structural step, Bakhardok flank, and Badkhyz-Karabil zone of highs.

6. Intensify work on favorable zones of the Murgab gas region.

SELECTED REFERENCES

Aksenov, A.A. and others, 1985, Oil and gas in sub-salt sediments [in Russian]: Moscow, Nedra, 205 p.

Alekhin, S. N., 1980, Formation-pressure anomaly factor in estimating gas potential of platform part of Turkmenistan [in Russian]: Geologiya Nefti i Gaza, no. 6, p. 20-26 (summary in Petroleum Geology, v. 18, no. 6).

Aliyev, I. M., and others, 1983, Oil-gas provinces of the USSR [in Russian]: Moscow, Nedra, 272 p.

Amurskiy, G. I., Zhabrev, I. P., Solov'yev, N. N., and Khusnutdinov, Z. B., 1984, Formation of Dauletabad-Donmez gas field [in Russian]: Sovetskaya Geologiya, no. 3, p. 11-21.

Andreyev, A. P., and Kolchina, G. I., 1981, Experiment in reduction of the gravity field for detecting the effect of cores of salt domes [in Russian]: Neftegazovaya Geologiya i Geofizika, no. 1, p. 34-37 (summary in Petroleum Geology, v. 18, no. 7).

Bakirov, A. A., and others, 1979, Oil-gas provinces and regions of the USSR [in Russian]: Moscow, Nedra, 456 p.

Chetverikova, O.P., Viktorova, N.S., and Pentina, T.Yu., 1982, Scales of oil and gas formation in the Mesozoic sediments of the Turan platform [in Russian]: Trudy VNIGNI, no. 240, p. 138-155 (English summary in Petroleum Geology, v. 20, no. 9).

Dikenshteyn, G. Kh., 1983, Oil-gas provinces of the USSR--a collection [in Russian]: Moscow, Nedra, 272 p.

Gavril'cheva, L.G., 1985, Paleogeographic conditions of accumulation of Upper Jurassic salt deposits in East Turkmenia [in Russian], <u>in</u> Obshchiye problemy galogeneza: Moscow, Nauka, p. 230-240 (English summary in Petroleum Geology, v. 22, no. 7).

Gavrilov, Ye.Ya., Goncharov, V.S., and Teplinskiy, G.I., 1985, Genesis of the gas of Dauletabad-Donmez gas-condensate fields [in Russian]: Geologiya Nefti i Gaza, no. 9, p. 35-39.

Luppov, N. P., 1972, Geology of the USSR [in Russian], v. 22, Turkmen. SSR: Moscow, Nedra, 768 p.

Luvishis, M. G., 1982, Nature of the Upper Jurassic carbonate sediments of the southeast part of the Chardzhou step [in Russian]: Neftegazovaya Geologiya i Geofizika, no. 2, p. 14-17 (summary in Petroleum Geology, v. 18, no. 8).

Maksimov, S.P., Stroganov, V.P., and Il'in, V.D., 1981, Satellite traps in structural pairs--new exploration target for oil pools in the Amu-Dar'ya predominantly gas region [in Russian]: Geologiya Nefti i Gaza, no. 3, p. 35-40 (English summary in Petroleum Geology, v. 19, no. 3).

Mavyev, N. Ch., and Nedirov, B. R., 1982, Lower Hauteriv sandy reservoirs of the Jurassic of Central Turkmenia [in Russian]: Neftegazovaya Geologiya i Geofizika, no. 10, p. 17-19 (summary in Petroleum Geology, v. 20, no. 4).

Mirzakhanov, M. K., Kubasov, L. M., and Khalliyev, S. P., 1975, Dauletabad--a new gas field in Badkhyze [in Russian]: Geologiya Nefti i Gaza, no. 8, p. 76-77 (summary in Petroleum Geology, v. 13, no. 8).

Oil and Gas Journal, 1982, Soviets report oil strike in Turkmenia: Oil and Gas Journal, August 30, p. 58-59.

Rogozhin, Ye.A. and Borisov, B.A., 1984, Similarity of geologic conditions of earthquakes in seismically active areas of the Kopet Dag and Dinaric Alps: Fizika Zemli, no. 11, p. 18-27, 1984.

Ryzhkov, O. A., Maksudov, I. Z., and Abdukakharov, A. M., 1983, Paleotectonic conditions of reef zones in Upper Jurassic carbonates of West Uzbekistan [in Russian]: Dokl. Akad. Nauk UzSSR, no. 1, p. 41-43 (summary in Petroleum Geology, v. 20, no. 3).

Semenovich, V. V., ed., 1976, Oil and Gas map of the USSR, scale 1:2,500,000: Moscow, Ministry of Geology, 16 sheets.

Sokolov, I. P., and Zelenin, N. A., 1979, New exploration targets in West Uzbekistan [in Russian]: Geologiya Nefti i Gaza, no. 6, p. 15-18 (summary in Petroleum Geology, v. 17, no. 6).

__________ 1980, New structures in the Karakul downwarp [in Russian]: Neftegazovaya Geologiya i Geofizika, no. 5, p. 20-22 (summary in Petroleum Geology, v. 17, no. 11).

Sudarikov, 1981, History of formation and problem of oil-gas potential of the Gaurdak evaporite belt:

Yanena, R. I., and Mamedov, Kh. M., 1982, History of tectonic development of Southeast Turkmenia [in Russian]: Izv. Akad. Nauk Turkmen SSR, Ser. fiz., tech., khim., geol. nauk, no. 5, p. 80-88 (summary in Petroleum Geology, v. 20, no. 1).

Yermolkin, V.I., Sorokova, Ye.I., and Filin, A.S., 1983, Paleotectonic and geochemical indicators of the genesis and accumulation of hydrocarbons on the Arabian and Turan platforms, in Osnovnyye printsipy formirovaniya zalezhey nefti i gaza: Moscow, Nauka, p. 195-201 (English summary in Petroleum Geology, v. 21, no. 4).

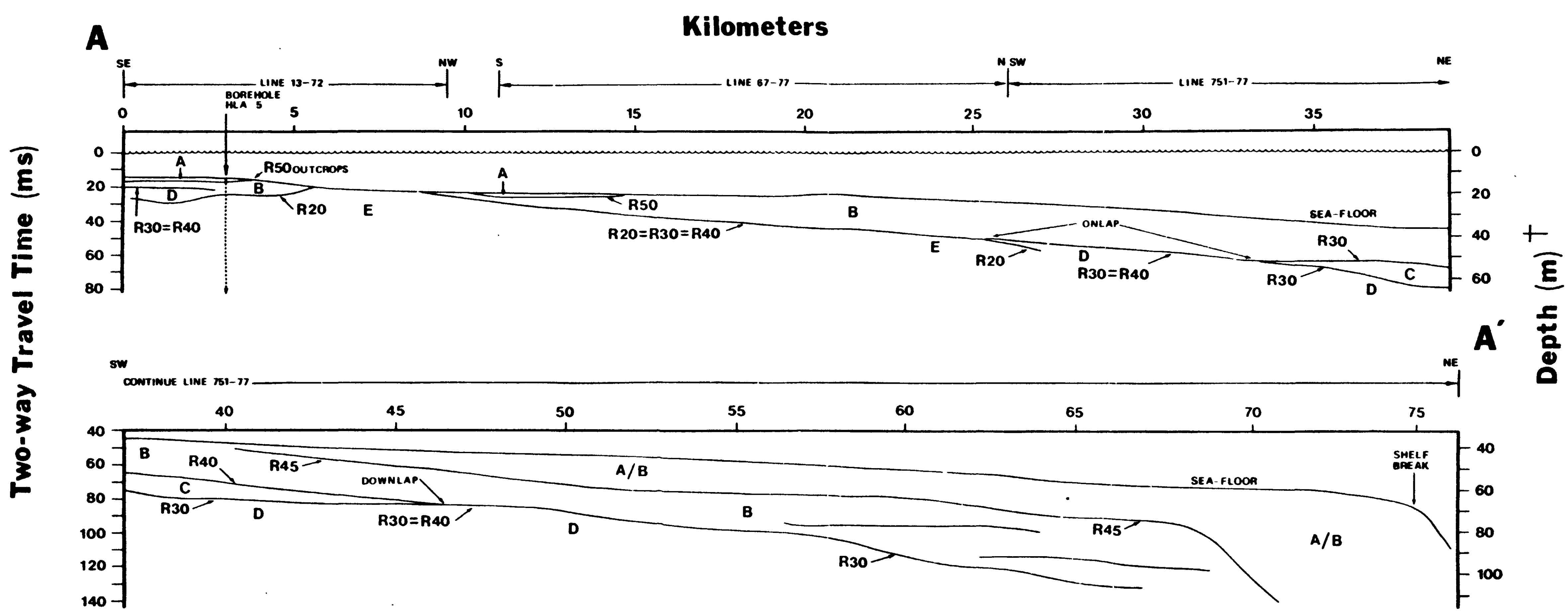
Yermolkin, V.I., Sorokova, Ye.I., Filin, A.S., and Bobyleva, A.A., 1985, Oil, gas, and condensate zoning in a petroleum province [in Russian]: Sovetskaya Geologiya, no. 9, p. 21-32 (translation in International Geological Review, v. 27, no. 11, p. 1304-1314.

_______, 1985, Phase zonality of regional oil-gas accumulation [in Russian]; Sovetskaya Geologiya, no. 9, p. 21-32 (English translation in International Geology Review, v. 27, no. 11, p. 1304-1314.

Zhabrev, I. P., and others, 1983, Gas and gas-condensate fields, a collection [in Russian]: Moscow, Nedra, 376 p.

Zharkov, M. A., Blagovidov, V. V., Zharkova, T. M., and Merzlyakov, G. A., 1982, Upper Jurassic salt deposits of Central Asia [in Russian]: Trudy Inst. Geologiya i Geofizika, no. 535, p. 3-18, 1982 (summary in Petroleum Geology, v. 20, no. 1).

PLATE 1



EXPLANATION

~~~~~~ - Sea-level

R30 - Reflector

A - Acoustic Sequence A

† Depth assuming 1600 m/s

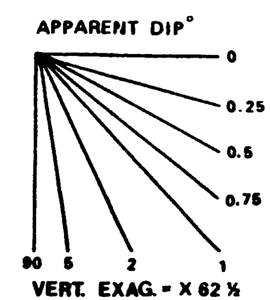


Plate 1. Cross-section A. See Figure 5-2 for cross-section location.
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PLATE 2

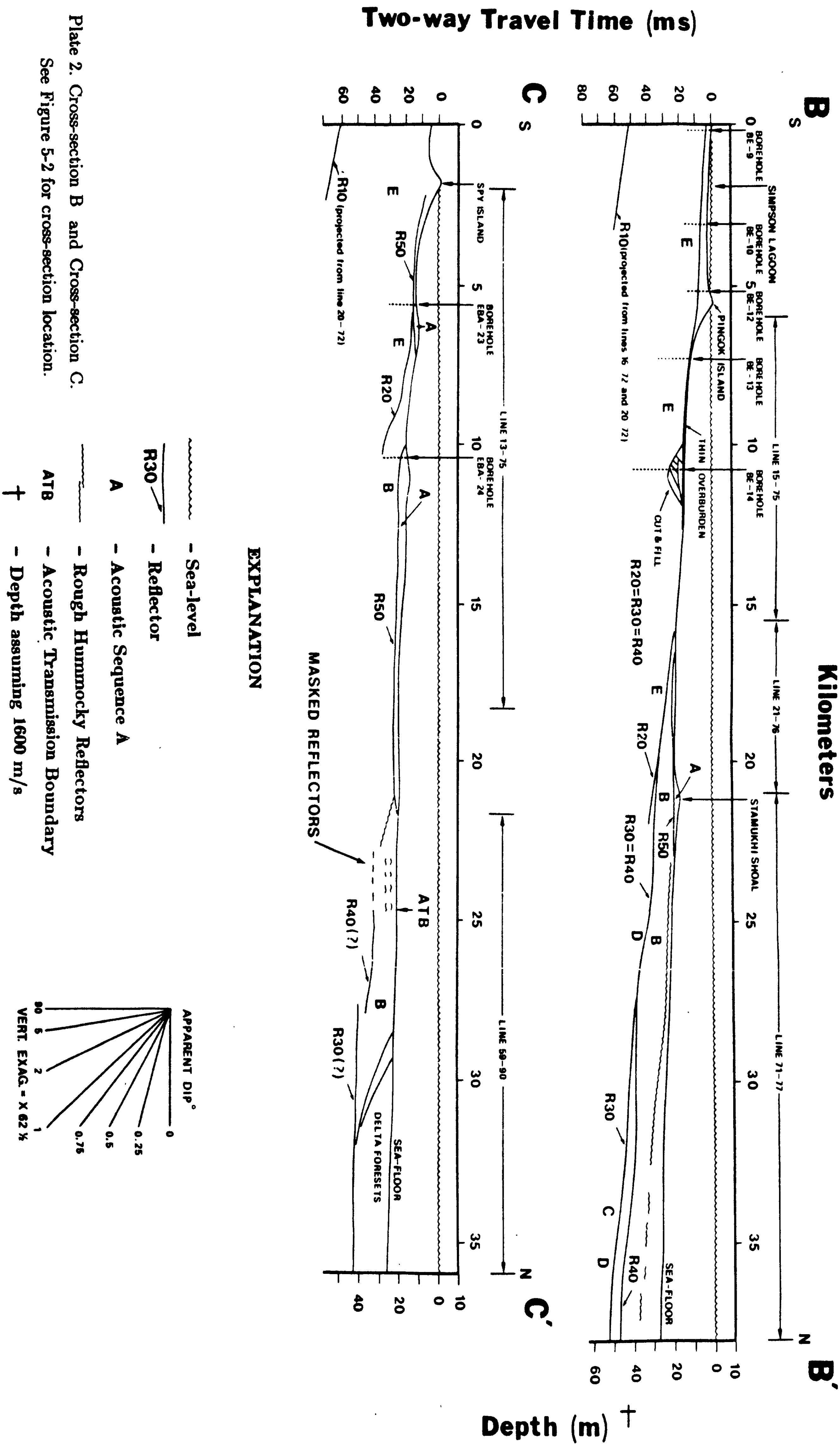

Plate 2. Cross-section B and Cross-section C.
See Figure 5-2 for cross-section location.