

# Assessment of Undiscovered Oil and Gas Resources of the Amu Darya Basin and Afghan–Tajik Basin Provinces, Afghanistan, Iran, Tajikistan, Turkmenistan, and Uzbekistan, 2011

Using a geology-based assessment methodology, the U.S. Geological Survey estimated volumes of undiscovered, technically recoverable, conventional petroleum resources for the Amu Darya Basin and Afghan–Tajik Basin Provinces of Afghanistan, Iran, Tajikistan, Turkmenistan, and Uzbekistan. The mean volumes were estimated at 962 million barrels of crude oil, 52 trillion cubic feet of natural gas, and 582 million barrels of natural gas liquids for the Amu Darya Basin Province and at 946 million barrels of crude oil, 7 trillion cubic feet of natural gas, and 85 million barrels of natural gas liquids for the Afghan–Tajik Basin Province.

## Introduction

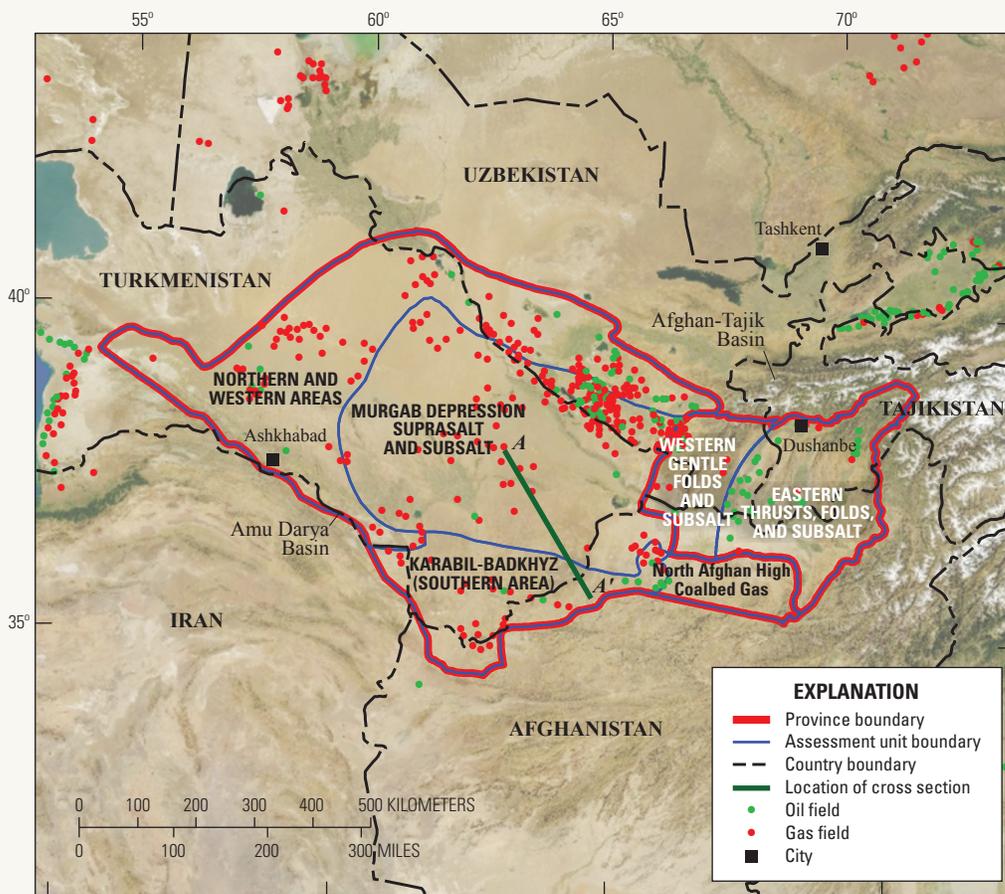
The U.S. Geological Survey (USGS) estimated volumes of undiscovered technically recoverable, conventional oil and gas resources of the Amu Darya Basin Province and the Afghan–Tajik Basin Province in Afghanistan, Iran, Tajikistan, Turkmenistan, and Uzbekistan, in south-central Asia (fig. 1). The assessment is part of a program to estimate petroleum resources for priority basins around the world, specifically for total petroleum systems (TPS) and assessment units (AU)

that are defined by their geologic attributes that are favorable for the generation and accumulation of petroleum. The Amu Darya Basin Province encompasses more than 417,000 square kilometers and the Afghan–Tajik Basin Province encompasses more than 97,000 square kilometers. This assessment was based on published geologic information and on commercial data from oil and gas wells and fields, and field production records.

## Total Petroleum Systems and Assessment Units

Both the Amu Darya and Afghan–Tajik Basins are interpreted to have originated as rift/sag basins (Ulmishek, 2004), which controlled the distribution of Mesozoic and Paleogene source rocks as well as oil and gas resources in the respective geologic provinces. The basins underwent compression and deformation during the late Paleogene through Neogene collision of India with the Eurasian continent. The greatest amount of deformation occurred in the Afghan–Tajik Basin Province because it is closer to the collision zone.

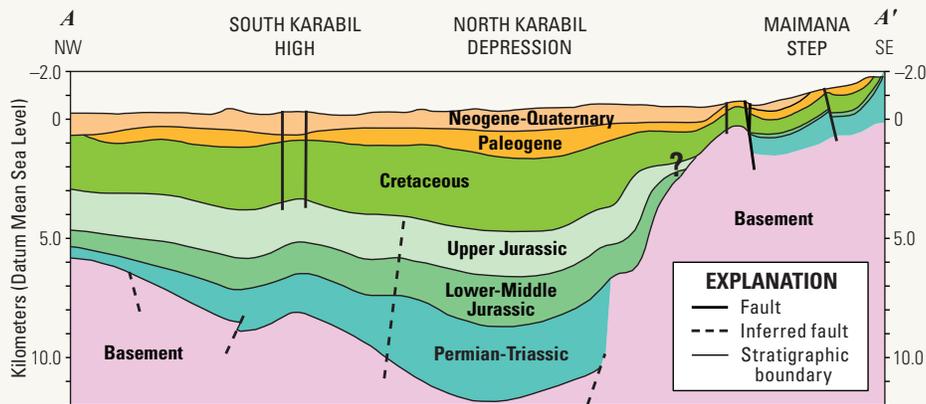
**Figure 1.** Generalized map showing the boundaries of the Amu Darya Basin and Afghan-Tajik Basin geologic provinces, centerpoints of oil and gas fields, and the location of geologic cross section A–A' shown in figure 2. Field data from IHS Energy (2009); geologic province boundaries from Persits and others (1998) and Klett and others (2006); base map from Environmental Systems Research Institute, Inc. (ESRI), 2010, ArcGIS Online Services–Ready-to-Use Content on Demand (<http://www.esri.com/software/arcgis/arcgisonline/index.html>).



One TPS was defined that spans the Amu Darya Basin and Afghan–Tajik Basin Provinces (table 1). The Mesozoic–Cenozoic Composite TPS is defined by petroleum source rocks ranging in age from Jurassic through Paleogene. Four AUs containing conventional undiscovered oil and gas resources were defined geologically within the Amu Darya Basin Province: (1) Northern and Western Areas, (2) Karabil–Badkhyz (Southern Area), (3) Murgab Depression Suprasalt, and (4) Murgab Depression Subsalt (figs. 1, 2). Two AUs containing conventional undiscovered oil and gas resources were defined geologically within the Afghan–Tajik Basin Province: (1) Western Gentle Folds and Subsalt, and (2) Eastern Thrusts, Folds, and Subsalt (fig. 1). Other AUs that possibly contain continuous accumulations also were identified based on the geochemical and physical properties of the source rocks, but these AUs were not quantitatively assessed in this study.

Major source rocks in both the Amu Darya Basin and Afghan–Tajik Basin Provinces are mudstones within the Lower–Middle Jurassic carbonaceous shales and coal and Upper Jurassic restricted-marine shale (Klett and others, 2006). Paleogene (Eocene) marine, or possibly lacustrine, shale is another source rock, but it is only present in the Afghan–Tajik Basin Province (Klett and others, 2006). Jurassic source rocks, at present, are in the gas-generation window throughout much of the Amu Darya and Afghan–Tajik Basins, except along the margins of the basins, where they are in the oil-generation window or immature. Maturation of Jurassic

source rocks was probably reached in Cretaceous to Paleogene time when the greatest amount of sediment was deposited. Paleogene source rocks at present are in the oil-generation window, having matured in the late Paleogene and Neogene by loading of thrust sheets that formed by collisional deformation. In the Amu Darya Basin Province, most known recoverable crude oil and natural gas were discovered in Jurassic clastic rocks, Jurassic carbonate reef- and platform-associated rocks, and Cretaceous clastic rocks (down to a depth of about 5,500 meters) (Klett and others, 2006). Most known recoverable crude oil and natural gas in the Afghan–Tajik Basin Province have been discovered in Upper Cretaceous carbonate rocks and in Paleogene clastic rocks (down to a depth of about 3,700 meters) (Klett and others, 2006). The regional seal rock is a thick Upper Jurassic evaporite section; other seal rocks include Jurassic, Cretaceous, and Paleogene intraformational shales. Identified traps include reactivated rift-related basement structures, compressional structures formed by Cenozoic deformation, fault-related structures, updip depositional-facies changes, updip depositional and erosional pinchouts, and various reef- and carbonate-platform-associated facies. The future potential for undiscovered conventional oil and gas accumulations is in structures and various reef and carbonate-platform facies beneath the Upper Jurassic evaporite section, which previously have not been fully exploited. High potential exists in Upper Jurassic slope and basin gravity-flow deposits in the subsalt section.



**Figure 2.** Geologic cross section for the Amu Darya Basin. See figure 1 for location. Approximate length of cross section is 275 kilometers. Modified from Aleshina and Bluket (1967).

## Assessment Results

Estimates of volumes of undiscovered technically recoverable, conventional oil and gas resources are shown in table 1. No attempt was made to estimate economically recoverable resources because it is beyond the scope of this study. In summary, the estimated mean volumes of undiscovered, technically recoverable, conventional oil and gas resources for the Amu Darya Basin Province are about 962 million barrels (MMB) of crude oil, 52,025 billion cubic feet (BCF) of natural gas (2,321 BCF of associated and dissolved natural gas, and 49,704 BCF of nonassociated natural gas), and 582 MMB

of natural gas liquids (55 MMB of natural gas liquids in oil accumulations and 527 MMB of total liquids in nonassociated gas accumulations). The estimated mean volumes of undiscovered, technically recoverable, conventional oil and gas resources for the Afghan–Tajik Basin Province are about 946 MMB of crude oil, 7,072 BCF of natural gas (225 BCF of associated and dissolved natural gas and 6,847 BCF of nonassociated natural gas), and 85 MMB of natural gas liquids (4 MMB of natural gas liquids in oil accumulations and 81 MMB of total liquids in nonassociated gas accumulations).

**Table 1.** Amu Darya Basin and Afghan–Tajik Basin Provinces assessment results (undiscovered, technically recoverable, conventional resources).

[MMB, million barrels; BCF, billion cubic feet. Results shown are fully risked estimates. For gas fields, all liquids are included under the natural gas liquids (NGL) category. F95 denotes a 95-percent chance of at least the amount tabulated. Other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable].

Total petroleum systems (TPS) and assessment units (AU)	Field type	Mean (expected) largest field size (MMB or BCF)	Total undiscovered resources											
			Oil (MMB)				Gas (BCF)				NGL (MMB)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
<b>Amu Darya Basin Province, Mesozoic–Cenozoic Composite TPS</b>														
Northern and Western Areas AU	Oil	12	145	215	315	221	267	427	661	441	1	1	2	1
	Gas	238					5,551	8,153	11,832	8,344	39	58	86	60
Karabil-Badkhyz (Southern Area) AU	Oil	18	65	108	171	112	165	275	443	286	<1	1	1	1
	Gas	429					2,311	3,762	5,832	3,877	15	25	40	26
Murgab Depression Suprasalt AU	Oil	10	5	12	41	16	11	34	129	48	<1	1	4	2
	Gas	238					1,151	1,894	2,961	1,953	13	22	36	23
Murgab Depression Subsalt AU	Oil	49	384	597	899	613	924	1,495	2,341	1,546	30	49	79	51
	Gas	2,938					21,735	34,564	52,539	35,530	249	406	632	418
<b>Total undiscovered petroleum resources</b>						962				52,025				582
<b>Afghan–Tajik Basin Province, Mesozoic–Cenozoic Composite TPS</b>														
Western Gentle Folds and Subsalt AU	Oil	8	27	43	66	44	54	92	149	96	1	2	3	2
	Gas	914					2,962	5,271	8,887	5,509	33	61	109	65
Eastern Thrusts, Folds, and Subsalt AU	Oil	24	599	881	1,282	902	81	126	191	129	1	2	3	2
	Gas	100					857	1,306	1,936	1,338	10	15	23	16
<b>Total undiscovered petroleum resources</b>						946				7,072				85

## References Cited

- Aleshina, Z.I., and Bluket, O.A., 1967, Yuzhnaya i yugovostochnaya okrainy Murgabskoy vpadiny; novaya perspektivnaya neftegazonosnaya oblast' Turanskoy plity (South and southeast margin of the Murgab basin — new petroleum-potential region of the Turan plate, *in* Varentsev, M.I., ed., *Tektonika neftegazonosnykh vpadin Sredney Azii i Kazakhstana* (Tectonic control of oil and gas in middle Asia and Kazakhstan): Moscow, Nauka, p. 109–115.
- IHS Energy, 2009 [includes data current through October 2009], International exploration and production database: Englewood, Colo., IHS Energy.
- Klett, T.R., Ulmishek, G.F., Wandrey, C.J., Agena, W.F., and the U.S. Geological Survey–Afghanistan Ministry of Mines and Industry Joint Oil and Gas Resource Assessment Team: Amirzada, A., Selab, A., Muty, S.A., Nakshband, H.G., Wardak, M.G., Aminulah, Wahab, A., Taylor, D.J., Hill, R.J., Pribil, M., King, J.D., Pawlewicz, M.J., Barker, C.E., Ahlbrandt, T.S., Charpentier, R.R., Pollastro, R.M., and Schenk, C.J., 2006, Assessment of undiscovered technically recoverable conventional petroleum resources of northern Afghanistan: U.S. Geological Survey Open-File Report 2006–1253, 1 CD-ROM. (<http://pubs.usgs.gov/of/2006/1253/>).
- Persits, F.M., Ulmishek, G.F., and Steinshouer, D.W., 1998, Map showing geology, oil and gas fields, and geologic provinces of the former Soviet Union: U.S. Geological Survey Open-File Report 97–470E, CD-ROM.
- Steinshouer, D.W., Klett, T.R., Ulmishek, G.F., Wandrey, C.J., Wahl, R.R., Hill, R.J., Pribil, M., Pawlewicz, M.J., King, J.D., Agena, W.F., Taylor, D.J., Amirzada, A., Selab, A., Mutteh, A-S., Haidari, G.N., and Wardak, M.G., 2006, Petroleum resource potential GIS of northern Afghanistan, 2006: U.S. Geological Survey Open-File Report 2006–1179, 1 CD-ROM. (<http://pubs.usgs.gov/of/2006/1179/>).
- Ulmishek, G.F., 2004, Petroleum geology and resources of the Amu-Darya Basin, Turkmenistan, Uzbekistan, Afghanistan, and Iran: U.S. Geological Survey Bulletin 2201-H, 32 p.

## For Further Information

Supporting geologic studies of total petroleum systems and assessment units, and reports on the methodology used in the assessment of the Amu Darya Basin and Afghan–Tajik Basin Provinces, as well as the assessment results, are available at the USGS Energy website: <http://energy.usgs.gov>.

## Amu Darya Basin and Afghan–Tajik Basin Provinces Assessment Team

T.R. Klett ([tklett@usgs.gov](mailto:tklett@usgs.gov)), Christopher J. Schenk, Craig J. Wandrey, Ronald R. Charpentier, Michael E. Brownfield, Janet K. Pitman, Richard M. Pollastro, Troy A. Cook, and Marilyn E. Tennyson.