



# Assessment of Undiscovered Petroleum Resources of Southern and Western Afghanistan, 2009

*Using a geology-based assessment methodology, the U.S. Geological Survey–Afghanistan Ministry of Mines Joint Oil and Gas Resource Assessment Team estimated mean undiscovered resource volumes of 21.55 million barrels of oil, 44.76 billion cubic feet of non-associated natural gas, and 0.91 million barrels of natural gas liquids in the western Afghanistan Tirpul Assessment Unit (AU) (80230101).*

## Introduction

The U.S. Geological Survey (USGS), in cooperation with the Afghanistan Ministry of Mines, assessed the undiscovered petroleum resource potential of western and southern Afghanistan. The assessment is part of U.S. and Afghan Government efforts to assist in the rebuilding of the Afghan economy and infrastructure through identification and development of natural resources.

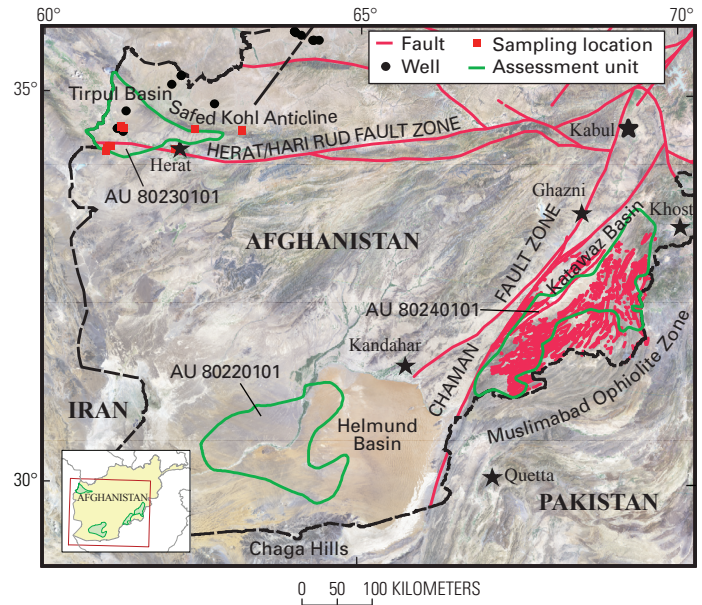
The Tirpul Basin is a transpressional basin located in western Afghanistan, extending from near Herat in the east, to the Iranian border in the west (fig. 1). The basin is generally bounded on the north by the Safed-Koh Anticline and on the south by the Herat/Hari Rud Fault Zone. The areal extent of the Tirpul Basin is approximately 8,700 km<sup>2</sup>. Significant exploration efforts during the 1970s and 1980s included gravity and magnetic surveys and the drilling of several exploratory wells. A more recent gravity and magnetic survey was completed in 2006. There is no oil or gas production in the Tirpul Basin.

The Helmund Basin is situated in southwestern Afghanistan (fig. 1), southwest of Kandahar and north of the Chaga Hills. For resource assessment purposes, the basin corresponds to an area in which gravity and magnetic data are interpreted to indicate a sedimentary rock thickness greater than 1,500 m (Drenth and Finn, 2008). Gravity and magnetic surveys are the only exploration efforts conducted to date. No rocks with petroleum potential are exposed in the basin.

The Katawaz Basin in southern Afghanistan (fig. 1) consists of accreted terrane in the collision zone of the Helmund and Indian tectonic plates. The areal extent of the entire basin is approximately 45,000 km<sup>2</sup>; it is bounded on the northwest by the Chaman Fault Zone and on the south and east by the Muslimabad Ophiolite Zone. Petroleum geology studies as well as gravity and magnetic surveys have been conducted in the basin. No exploratory wells have been drilled and no seismic surveys have been conducted in the Afghan part of the basin.

## Geologic Definition of Assessment Units

Both the Tirpul Basin Upper Mesozoic–Paleogene Total Petroleum System (TPS) (802301) and Tirpul Assessment Unit (AU) (80230101) boundaries are coincident with the Tirpul



**Figure 1.** Satellite image of southern and western Afghanistan showing prospective assessment units of the Tirpul Basin (AU 80230101), Helmund Basin (AU 80220101), and Katawaz Basin (AU 80240101); well and sample locations; and relevant faults. Image from National Geospatial Intelligence Agency, 12 July 2004, unclassified.

Basin boundary (fig. 1). The areal extent of the TPS and AU is approximately 8,700 km<sup>2</sup>. Recurrent movements of multiple fault blocks within the basin caused variations in deposition and erosion of the rock strata, resulting in uncertainty as to the existence and quality of source and reservoir rocks in individual fault blocks. Several rock units in the Jurassic to Eocene strata may be potential source rocks. However, none of the rocks sampled thus far (fig. 1) demonstrates sufficient organic richness or thermal maturity to generate hydrocarbons. Oil seeping from one abandoned well indicates that oil generation has occurred within the basin. Analysis of the oil indicates that it was generated from a Tertiary age source rock deposited in a saline lacustrine environment.

The Helmund Basin Paleocene-Miocene TPS (802201) and Paleocene-Miocene AU (80220101) are hypothetical. The Paleocene-Miocene TPS and Paleocene-Miocene AU boundaries are coincident. The area included in the TPS and AU is the area in which magnetic gravity surveys indicate a sedimentary rock thickness greater than 1,500 m. The extent of the AU and TPS is approximately 41,000 km<sup>2</sup>. Bounding and within the AU are intrusive and extrusive igneous rocks of significant areal extent.

The Katawaz Basin Eocene-Miocene TPS (802401) and Eocene-Miocene Deltaic AU (80240101) are hypothetical. The Eocene-Miocene TPS and Eocene-Miocene Deltaic AU boundaries are coincident. The area included in the TPS and AU is the

**Table 1.** Western and Southern Afghanistan assessment results.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas. MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as NGL (natural gas liquids). Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95 percent chance of at least the amount tabulated; other fractiles are defined similarly. AU probability is the chance of at least one accumulation of minimum size within the AU. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable]

Total Petroleum Systems (TPS) and Assessment Units (AU)	AU Probability	Field Type	Total Undiscovered Resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
<b>Upper Mesozoic–Paleogene TPS</b>														
Tirpul AU	0.336	Oil	0	0	102.10	21.55	0	0	171.01	33.65	0	0	0	0
		Gas					0	0	224.97	44.76	0	0	4.62	0.91
<b>Paleocene–Miocene TPS</b>														
Paleocene–Miocene AU	0.002	Oil	Not quantitatively assessed											
		Gas												
<b>Eocene–Miocene Deltaic TPS</b>														
Eocene–Miocene Deltaic AU	0.064	Oil	Not quantitatively assessed											
		Gas												
<b>Total Conventional Resources</b>						<b>21.55</b>				<b>78.41</b>				<b>0.91</b>

area where magnetic and gravity surveys indicate sedimentary rock thickness greater than 1,500 m. The extent of the AU and TPS is approximately 27,000 km<sup>2</sup>. Potential source rocks are Eocene and Oligocene marine and deltaic shales and mudstones. High thermal maturity values for surface samples indicate that the AU will be gas-prone. Continued extensive deformation and destruction of the basin’s potential reservoir rocks and traps greatly reduce the chances for the entrapment and preservation of significant quantities of oil or gas.

## Summary

Investigation of the petroleum resource potential of southern and western Afghanistan has been very limited, although considerable exploration has previously occurred in both the Amu Darya and Afghan-Tajik Basins of northern Afghanistan. There has been no exploratory drilling in the Helmund Basin or Afghan part of the Katawaz Basin, and no more than five exploratory wells have been drilled in the Tirpul Basin. Continued tectonic activity has compromised both reservoir quality and trap integrity in all three basins.

The Assessment of Undiscovered Petroleum Resources of Southern and Western Afghanistan is based on the geologic elements of a total petroleum system, which include (1) source-rock presence, richness, type, maturation, generation, and migration; (2) presence and quality of reservoir rocks; and (3) time of trap formation with respect to petroleum migration, trap size, and type. Where available, data from studies of geophysics, geochemistry, petroleum geology, tectonics, and analog basins were used to aid in estimating the number and sizes of undiscovered petroleum accumulations. The minimum field mean field size quantitatively assessed was 5 million barrels of oil (MMBO) and 30 billion cubic feet of gas (BCFG).

## Resource Summary

The U.S. Geological Survey–Afghanistan Ministry of Mines Joint Oil and Gas Resource Assessment Team assessed undiscovered conventional, technically recoverable petroleum (discovered reserves not included), estimated a mean undiscovered resource of 21.55 MMBO, a mean of 44.76 billion cubic feet of (BCF) of non-associated natural gas (table 1), and a

mean of 0.91 million barrels of natural gas liquids (MMBNGL) in the western Afghanistan Tirpul (AU) (80230101). The hypothetical Katawaz Basin Eocene-Miocene TPS (802401) and Eocene-Miocene Deltaic AU (80240101) and Helmund Basin Paleocene-Miocene TPS (802201) and Paleocene-Miocene AU (80220101) could not be adequately quantitatively assessed because the cumulative geologic chance or risk of discovering a field containing 5 MMBO or 30 BCFG or larger was less than 10 percent and geologic data were very limited.

## Reference

Drenth, B.J., and Finn, C.A., 2008, Preliminary interpretation of regional gravity and magnetic data over southwest Afghanistan, Eos Transaction of the American Geophysical Union. AGU, v. 89, no. 53, Fall Meeting Supplement, Abstract NS22A–02.

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## Further Information

Supporting geologic studies of total petroleum systems and assessment units and reports on the methodology used in the North Afghanistan petroleum resource assessment are in progress. Assessment results are available at the USGS Central Energy Team Web site: <http://energy.cr.usgs.gov/oilgas>.

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