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INSIDE

South Caspian Basin: Young, Cool, and Full of Promise

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ABSTRACT

The South Caspian Basin comprises a unique set of geologic parameters that rank it among the most prolific hydrocarbon regions of the world. Surrounded by compressional orogens, the basin has accumulated up to 25 km of sediment, with more than 10 km of this fill deposited in the last 6 m.y. This recent, rapid burial has resulted in such low temperature gradients that hydrocarbons are still being actively generated at depths between 8 and 12+ km. The anticlinal structures in the basin are large, and interpreted to be buckle folds overlying a regional detachment based on the analysis of regional 2-D seismic data. The combination of a prolific hydrocarbon system, large undrilled structures, and a favorable political climate for foreign investment has focused considerable industry attention on the potential of this basin.

INTRODUCTION

The South Caspian Basin lies within a belt of Tertiary to Holocene compression associated with the Alpine-Himalayan orogenic belt. The sedimentary fill of the South Caspian Basin, however, remains relatively undeformed compared to the adjacent Caucasus, Kopet Dag, and Elburz fold and thrust belts (Fig. 1). Deformation in the South Caspian Basin is expressed as a series of large folds that are commonly pierced by mud

Caspian Basin *continued on p. 2*

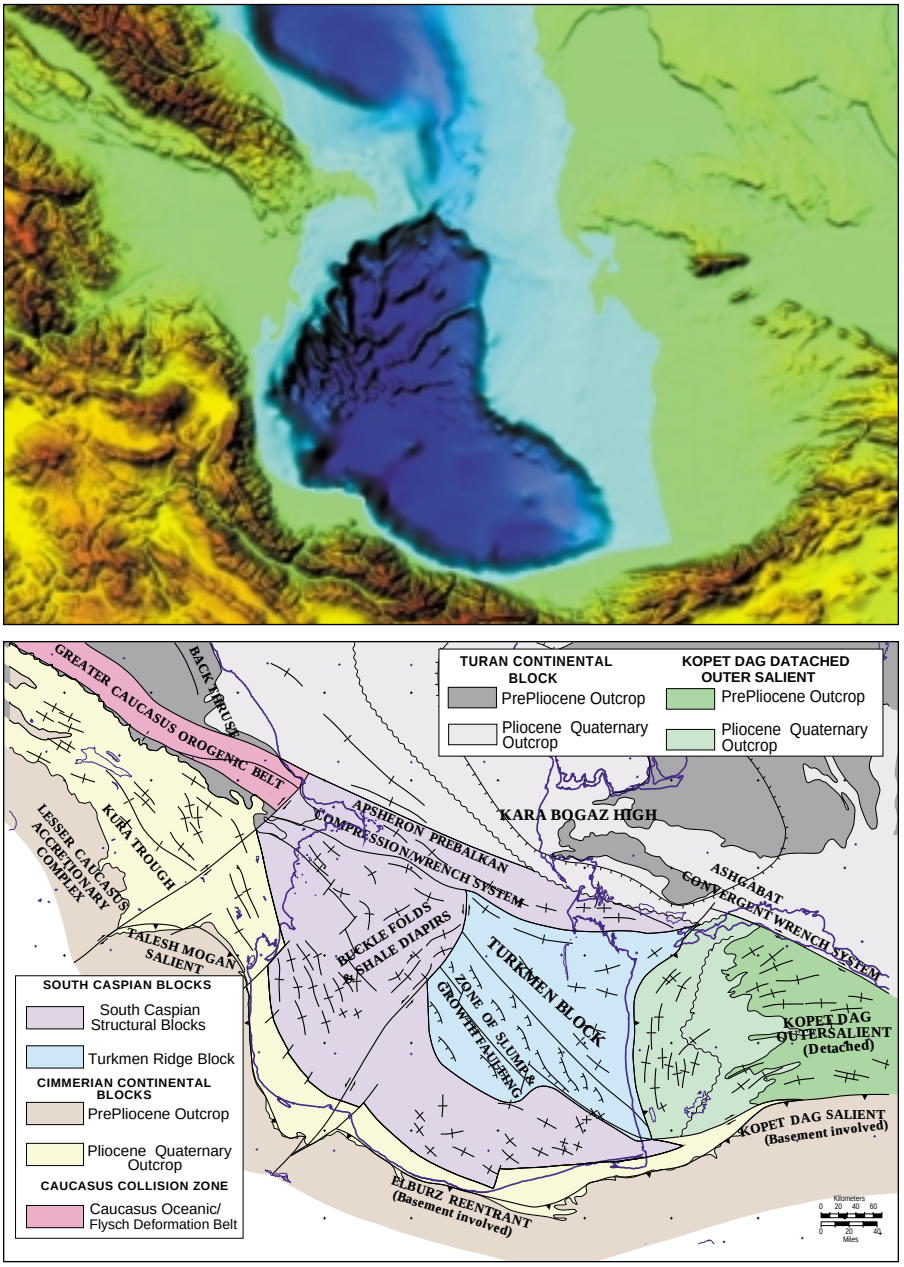

Figure 1. Upper: Merged bathymetry and digital topography of the South Caspian Sea and surrounding areas. The elongate subsea ridges present on the bathymetry are the sea floor expression of large, subsurface anticlinal folds (see Fig. 4). Lower: Structural elements of the South Caspian Sea and surrounding areas (modified from Philip et al., 1989, Berberian and King, 1981; Adamia et al., 1977; Nalivkin, 1976; Huber, 1978).

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June 21, 1996

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April 14, 1999

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May 1, 1999

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Kemble Widmer
Pennington, New Jersey
March 6, 1999

Caspian Basin *continued from p. 1*

diapirs and associated mud volcanoes, and which appear as linear physiographic features on the Caspian Sea floor (Fig. 1). Late Miocene–Pliocene uplift of the surrounding region isolated the basin, and made it a depocenter for the enormous volumes of sediment that were shed from both the nearby orogens and the Russian Platform. The resulting, rapid burial rates led to low temperature gradients that allowed hydrocarbon generation and preservation to great depths (Abrams and Narimanov, 1997).

The South Caspian region is also one of the world's oldest oil-producing regions. As early as the 4th century B.C., Alexander the Great is reported to have utilized these resources during his campaigns. Later in the 13th century, Marco Polo wrote of the oil seeps in the region around Baku (Yer-

WASHINGTON REPORT

Bruce F. Molnia, *bmolnia@erols.com*

Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. These reports present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

Science and Creationism, a New View from the National Academy of Sciences

Scientists, like many others, are touched with awe at the order and complexity of nature. Indeed, many scientists are deeply religious. But science and religion occupy two separate realms of human experience. Demanding that they be combined detracts from the glory of each.

—National Academy of Sciences President Bruce Alberts

In late April, the National Academy of Sciences (NAS) released *Science and Creationism,* an updated revision of its 1984 statement on the topics of evolution and creationism theory. In the new *Science and Creationism,* the NAS states unequivocally that creationism has no place in any science curriculum at any level.

Science and Creationism accomplishes this in two ways. First, a strong scientific argument is presented that clearly describes the theory of evolution. Second, the differences between creationism, on one hand, and science and the theory of evolution, on the other, are described and contrasted. Briefly and clearly, the 35-page booklet explores the origin of life, the universe, and Earth, explains the current scientific understanding of biological evolution, discusses human evolution, and presents answers to seven frequently asked questions about evolution and creationism. These questions are: (1) What is evolution? (2) Isn't evolution just an inference? (3) Is evolution a fact or a theory? (4) Don't many famous scientists reject evolution? (5) If humans evolved from apes, why are there still apes? (6) Why can't we teach creation science in my school? and (7) If evolution is taught in schools, shouldn't creationism be given equal time?

Science and Creationism was issued to serve as a companion volume to *Teaching About Evolution and the Nature of Science,* a longer, more comprehensive review of evolution. The purpose of *Teaching About Evolution and the Nature of Science,* issued in 1998, is to provide educators and policy-makers with tools to help integrate lessons about the scientific theory with basic biology for children in kindergarten through grade 12. The guidebook was written by a group of scientists and educators who have been involved extensively in education and research on evolution. *Teaching About Evolution and the Nature of Science* does an effective job of: (1) summarizing the massive amount of scientific evidence in support of evolution and suggesting effective ways of teaching it; (2) explaining the nature of science and how it differs from other ways of knowing about the natural world; (3) providing eight sample activities that teachers can use to develop students' understanding of evolution and scientific inquiry; and (4) answering some of the most frequently asked questions about the scientific, legal, and educational issues surrounding the teaching of evolution.

Although teachers' organizations such as the National Science Teachers Association, the National Association of Biology Teachers, the National Science Education Leadership Association, and many others have rejected the science and pedagogy of creation science and have strongly discouraged its presentation in the public schools, many teachers are reluctant to teach evolution because of pressures from special-interest groups to downplay or eliminate it as part of the science curriculum. *Teaching About Evolution and the Nature of Science* attempts to deal with this issue.

Science and Creationism was prepared with a different purpose. Although it summarizes many key aspects of the theory of evolution, it also addresses and analyzes arguments and positions taken by various advocates of creation science by presenting analyses and interpretations of the arguments. *Science and Creationism* broadly and successfully presents a case for prohibiting the presentation of religious teachings about creationism in the classroom.

Science and Creationism concludes: "No body of beliefs that has its origin in doctrinal material rather than scientific observation, interpretation, and experimentation should be admissible as science in any science course. Incorporating the teaching of such doctrines into a science curriculum compromises the objectives of public education. Science has been greatly successful at explaining natural processes, and this has led not only to increased understanding of the universe, but also to major improvements in technology and public health and welfare. The growing role that science plays in modern life requires that science, and not religion, be taught in science classes."

The report was prepared by the Steering Committee on Science and Creationism, under the direction of the Office on Public Understanding of Science. The committee was chaired by Francisco J. Ayala from the University of California, Irvine. Earth science community members include: Ralph J. Cicerone, University of California, Irvine; G. Brent Dalrymple, Oregon State University; Stephen J. Gould, Harvard University; Donald Kennedy, Stanford University; George Rupp, Columbia University; and Steven M. Stanley, Johns Hopkins University. *Science and Creationism* is very attractive in presentation and authoritative in content. It should quickly become a standard reference, useful to anyone concerned about America's scientific literacy. Both *Science and Creationism* and *Teaching About Evolution and the Nature of Science* are available at the NAS Web site (www.nas.edu).■

gin, 1991). Azerbaijan has been producing oil commercially for more than 150 years, drilling the first oil well in 1848, 11 years before Colonel Drake's oil well in Pennsylvania. The industry's first offshore operations were undertaken in the south Caspian Sea in 1924 from wooden offshore platforms (Narimanov and Palaz, 1995).

In the Azerbaijan sector of the South Caspian Basin, approximately 11 billion oil-equivalent barrels of cumulative production have been reported from onshore and nearshore fields, with an additional 10 billion oil-equivalent barrels of proven, but undeveloped reserves (Narimanov and Palaz, 1995; George, 1993). Estimates for undiscovered offshore potential vary widely, but most indicate volumes that rival total production in the North Sea (Alekbarov, 1998). After the breakup of the Soviet Union, a significant area of the South Caspian was opened to western investment, with ensuing industry competition for access to exploration and development opportunities. Of an estimated 50 potential offshore structures, 13 Production Sharing Agreements have been signed with the Azeri government to date, with over $30 billion in planned foreign inves-

Caspian Basin *continued on p. 4*

Figure 2. Part of the South Caspian in the vicinity of Baku, Azerbaijan, showing some of the existing oil and gas fields and prospective offshore structures. Black represents discovered oil fields, gray represents discovered gas fields, and white represents structures with wells and/or signed exploration or production agreements with the Azerbaijan government.

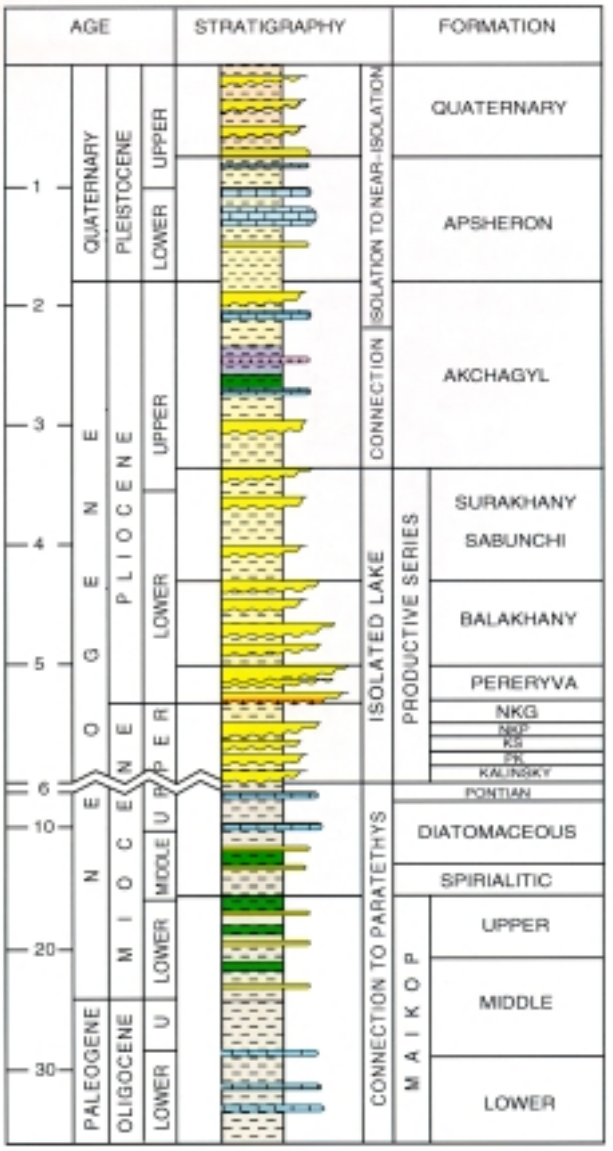


Figure 3. Schematic stratigraphic column for the central South Caspian Basin. Note the break in linear time scales at 6 Ma.

Caspian Basin *continued from p. 3*

ments (Fig. 2; Narimanov and Palaz, 1995; Alekbarov, 1998). Much of the remaining exploration potential lies in water depths between 300 and 700 m, and will require drilling to vertical depths of more than 6000 m.

TECTONIC AND DEPOSITIONAL OVERVIEW

Geophysical investigations of the crustal structure of the South Caspian Basin suggest it is underlain by oceanic to sub-oceanic crust (Rezanov and Chamo, 1969; Neprochnov et al., 1970; Priestley et al., 1994). Although most workers accept this interpretation, there is some debate as to the origin of the South Caspian Basin. Some of the proposed tectonic mechanisms include: a trapped remnant of early Mesozoic oceanic crust (Berberian, 1983), a Cretaceous to Paleogene strike-slip–related pull-apart basin (Apol'skiy, 1974), and a Middle to Late Jurassic marginal basin to the Tethys Ocean (Zonenshain and LePichon, 1986). In our opinion, regional geologic relationships and observations from seismic data best support a marginal basin origin. Regional geologic relationships that support back-arc extension include: Middle Jurassic ophiolitic assemblages and evidence for extension in the Caucasus (Adamia et al., 1977), Jurassic depositional systems that thicken northward from Iran (Rad, 1986), and evidence for Middle Jurassic extension in the Kopet Dag Mountains (Zonenshain and LePichon, 1986). Regional 2-D seismic surveys show rapid thinning of strata across extensional structures along the basin margins, consistent with an increase in crustal thickness in these areas (Shikalibeily and Grigoriants, 1980; Neprochnov et al., 1970).

Middle to Late Jurassic extension occurred behind a volcanic arc that stretched along the margin of southern Eurasia and the Tethys Ocean (Zonenshain and LePichon, 1986; Huber, 1978; Nalivkin, 1968). From the Jurassic through the Paleogene, the South Caspian marginal basin formed part of a larger seaway that reached from eastern Turkmenistan to the Black Sea (Vinogradov, 1968; Berberian and King, 1981). During this time, approximately 8 to 10 km of sediment accumulated in the basin.

In the late Paleogene, the Arabian and Eurasian plates began to collide (Zonenshain and LePichon, 1986). Subsequent regional uplift led to episodic marine restriction and the creation of euxinic conditions in the South Caspian Basin. Organic-rich calcareous and diatomaceous black shales of the Oligocene–lower Miocene Maikop Formation and the middle-upper Miocene Diatomaceous Series were deposited (Fig. 3). In the late Miocene, renewed tectonism caused the backarc seaway to be uplifted and exposed, isolating the deeper Black and Caspian Seas. The South Caspian Basin became an inland, freshwater lake (Kerimov et al., 1991), where river systems draining the Caucasus, Russian Platform, Kopet Dag-Tien Shan, and Elburz Highlands delivered large volumes of sediment. Nonmarine strata of the Productive Series were deposited at this time, which is the primary reservoir interval in the South Caspian Basin (Fig. 3).

Continued compression in the late Pliocene led to renewed uplift in the region and the onset of major, widespread folding in the South Caspian Basin. The fact that the sedimentary fill of the basin is less deformed than the surrounding orogens has been attributed to the region being located in a tectonic "shadow" between the collisional loci of the Arabian and Indian plates (Burtman, 1989). Compressional deformation and structural growth continued through the Quaternary to Holocene and has been accompanied by shale diapirism and associated mud volcanism. Marine conditions were briefly reestablished in the late Pliocene in an event referred to as the "Akchagyl transgression" (Fig. 3). This was followed once again by isolation to near-isolation of the basin, and the deposition of Quaternary to Holocene sediments under conditions described as alternating freshwater and shallow brackish marine (Degens and Paluska, 1979).

SOUTH CASPIAN BASIN HYDROCARBON SYSTEM

Structural Style

Compressional deformation within the South Caspian Basin is expressed as numerous elongate anticlines (Figs. 1, 2, and 4). These structures generally trend northwest, with a few marked deviations from this trend that suggest some element of basement control on structural grain (Fig. 1). Based on the structural analysis of regional 2-D seismic data, the majority of the structures are interpreted to be large buckle folds overlying a regional ductile detachment zone at depth. In this interpretation, upper Miocene to Holocene sediments behaved in a relatively rigid fashion, deforming as folds by bedding-parallel flexural slip. The folds are relatively symmetrical, and lack a consistent sense of vergence as would be expected in either fault bend or fault propagation folds (Fig. 4). A buckle fold interpretation is also supported by low-angle reverse faults in the lower parts of the folds, and normal faults in the upper part. These two fault patterns are separated by an inferred neutral zone of essentially no extensional or compressional strains (Fig. 4).

Wall and Wiener (1998) used structural balancing to check the viability of the buckle fold interpretation. When the Miocene through Holocene sediments are progressively unfolded in the reconstruction, the structural level at which the strata are detached is at approximately 10–12 km, consistent with the interpreted location of the Maikop shale interval on seismic records. The detachment zone for these buckle folds is interpreted to have deformed by ductile flow within a mobile, overpressured, shale-rich zone. On the basis of the structural balancing and regional stratigraphic relationships, the detachment is placed within the Maikop shale, the primary source rock in the basin (Fig. 3). The Maikop interval is interpreted to occur at approximately 10–12 km on deep seismic records, and overpressured as a result of in situ hydrocarbon generation (Inan et al., 1997).

The timing for the onset of folding can be clearly determined from seismic data. Across most structures, there is a relatively constant sedimentary thickness to the top of the Surakhany Formation (Figs. 3 and 4). Above this interval, the sedimentary section displays marked thinning over the crest and onlap onto the flanks of the growing structures. The stratal thinning begins with deposition of the Akchagyl Formation (Figs. 3 and 4). Isotopic age dates reported from ash beds in the lower part of this formation indicate a time for onset of approximately 3.4 Ma (Chumakov et al., 1988).

Shale Diapirism and Mud Volcanoes

The South Caspian Basin is characterized by numerous onshore and offshore mud volcanoes fed by shale diapirs. Within the context of the buckle fold mechanism discussed above, the primary source for the shale diapirs is likely the ductilely deformed, overpressured Maikop shale. This interpretation is consistent with the occurrence of Oligocene-Miocene shales collected from mud volcano ejecta from onshore localities (Dadashev et al., 1995).

Mud volcanoes have been the subject of research by Azeri geoscientists for many years because of their association with

Caspian Basin *continued on p. 6*

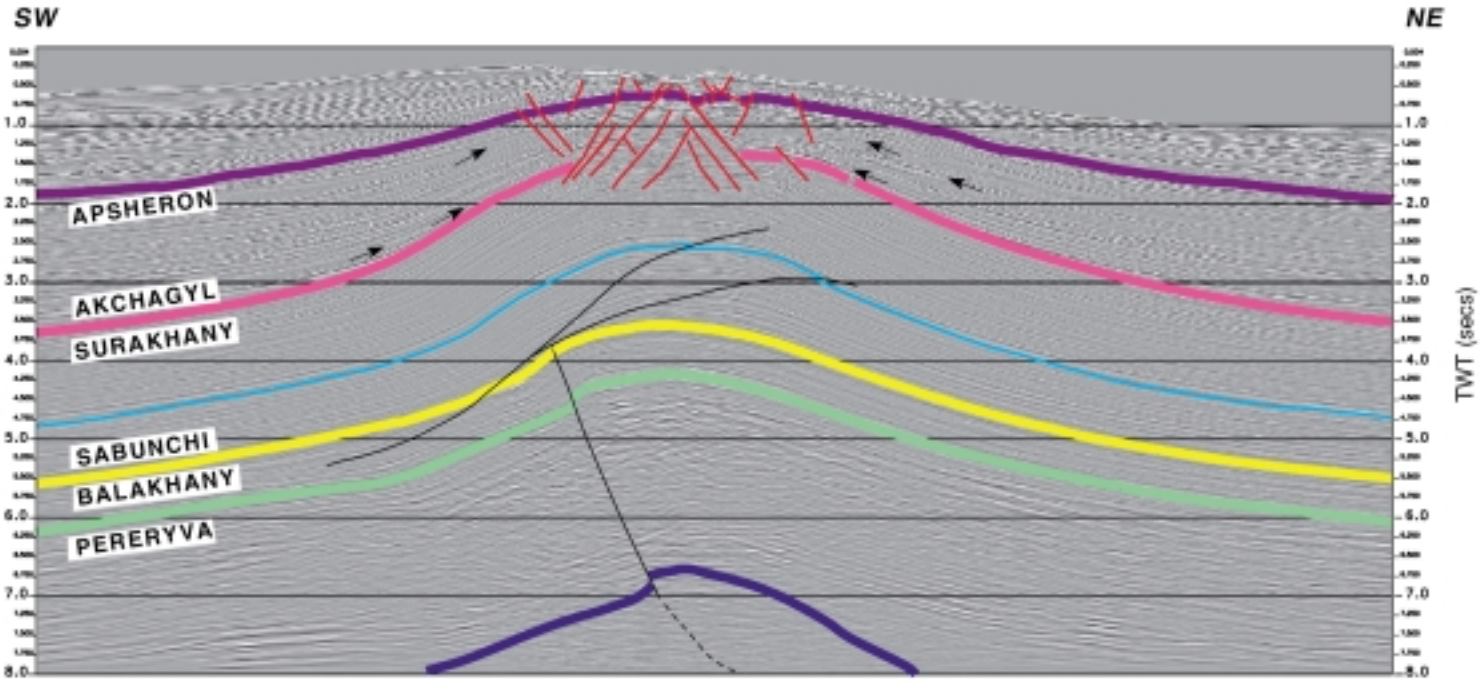
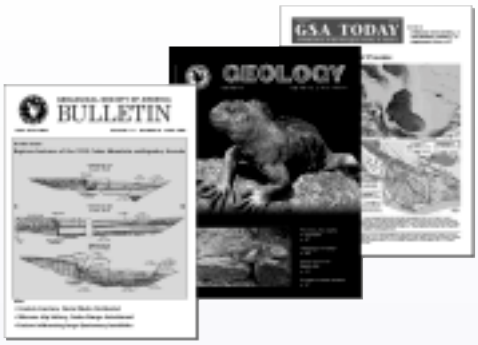


Figure 4. Seismic line, approximately 23 km long, across a typical South Caspian structure. Note the crestal normal faults in the shallow section and the low-angle reverse faults in the lower part of the fold. These two fault regimes are separated by an inferred neutral surface within the lower Surakhany Formation. Also note the thinning and onlap of strata above the top Surakhany Formation (pink surface), indicating the onset of structural growth. Use of seismic data courtesy of Caspian Geophysical.

YOUR STRATEGIC PLAN IN ACTION

This series focuses on elements of GSA's Strategic Plan and its benefits to members. Look for specific examples of the Strategic Plan in action in future issues of GSA Today.



Publications Survey Aids Planning

Peg Lehr, *Director of Publications*

GSA publications should include field guides, conference proceedings, on-line journals, and articles on demand, according to responses to a recent member survey.

A sampling of 2,235 U.S. member subscribers to the *GSA Bulletin* and *Geology* and members who do not subscribe were mailed a four-page survey in January 1999. A total of 1,213 individuals responded. The survey consisted of 30 questions regarding the GSA publications *Bulletin, Geology,* and *GSA Today,* GSA's Web site, and potential products that GSA might develop. The survey is a strategy of Goal 1, Objective 2 of the GSA Strategic Plan: "To maintain the quality and increase the vitality of publications."

New Products

Respondents indicated that the top five choices for new products were field guides (57%), digital maps (56%), on-line, full-text journals (54%), conference proceedings (33%), niche publications (28%), and an article-on-demand service (26%). To develop those projects, GSA has

- Appointed a field guide editor and will publish the 1999 Annual Meeting field guides; these will be for sale in the GSA Bookstore and in the Registration area during the meeting, and through GSA headquarters after the meeting;
- Begun to create an action plan for placing the *Bulletin* and *Geology* on-line by 2001;
- Begun to investigate an article-on-demand service so members can create their own "virtual libraries" from GSA journals that will be published on-line in full text format.

Bulletin

Respondents indicated that the usefulness of the *Bulletin* in their professional work has remained the same over the past two years (61%), and 39% find it very useful or useful. Some (35%) said that they want synthesis articles on particular areas of research; others voted for multidisciplinary thematic issues (20%), shorter articles (10%), and commentaries from noted researchers (9%). A large majority of respondents (75% for *Bulletin;* 77% for *Geology*) indicated that they save or file publications for future reference.

Of the responses, 69% indicated that readers were very satisfied or satisfied with the *Bulletin,* 22% were somewhat satisfied, and 9% were not satisfied. A review of the responses shows a correlation between "not satisfied" and perception of "relevance." A majority of the 9% who were not satisfied said that relevance of *Bulletin* articles to their work is low.

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anticlines, and therefore hydrocarbon traps (e.g., Dadashev et al., 1995). Mud volcanoes range in size from tens of centimeters high to many kilometers wide with hundreds of meters of relief (Fig. 5).

Caspian mud volcanoes have been known for spectacular eruptions that have sent 50-m-wide columns of flame more than 200 m into the air (Dadashev et al., 1995). More than 1,000 years ago, the Caspian region was known as "the land of eternal fires" because of burning oil and gas seeps and mud volcano eruptions (George, 1993), and the "pillars of fire" are said to have been worshipped by the Zoroastrians (Yergin, 1991). The gases associated with the volcanoes are mostly hydrocarbons, 82% to 98% of the total gases being methane (Dadashev et al.,

Figure 5. Mud volcano outcrop near Baku, Azerbaijan. Note shield volcano morphology and person in distance for scale.

Respondents were asked to rank 10 components of publication—relevance, credibility, timeliness, quality, prestige of journal, length of papers, time from acceptance to publication, layout and design, technical contents, color illustrations. For the *Bulletin,* prestige and quality rated very high with respondents; relevance to their work and time from acceptance to publication rated low.

Respondents said that they use the table of contents as their primary guide and that the focus for both *Bulletin* and *Geology* is right on target.

Geology

Usefulness of *Geology* in their professional work has remained the same over the past two years for 63% of the respondents, and 59% find it very useful or useful. Respondents said that they want synthesis articles on particular areas of research (22%), multidisciplinary thematic issues (22%), and commentaries from noted researchers (16%), as well as opinion articles (11%). The inclusion of commentaries and opinion articles in responses indicates that readers are interested in adding a more dynamic element to the publications, enhancing the current "reporting" structure of the journals.

Rating their overall satisfaction with *Geology,* 87% indicated that they were very satisfied or satisfied, 11% were somewhat satisfied, and 2% were not satisfied. Respondents rated *Geology* excellent in prestige, timeliness, layout and design, and length of papers.

GSA Today

The Society's monthly news publication was rated very useful or useful by 60% of the respondents, somewhat useful by 30%, and of little or no use by 9%. Respondents were adamant that *GSA Today* should continue the one-per-month science articles (94%) and that the publication be continued as a member benefit (84%). They also want both provocative, untested ideas and reviews of new topics.

Respondents said that they want (in descending order of choice) geoscience news, synthesis articles, commentary, book reviews, advertising, editorials, integrated systems science articles, opinion articles, shorter articles, more color, and longer articles. The inclusion of geoscience news far outstripped other activities. A majority of respondents checked multiple answers. Several respondents indicated that they believe *GSA Today* should be a news and general interest vehicle rather than a headquarters news vehicle.

Respondents were polled about the development of more product advertisements in *GSA Today,* and 71% approved of the idea, particularly if more advertising would help subsidize larger issues or reduce the amount of money allocated from dues to pay for issues of *GSA Today.*

Web Usage

Of the respondents who had visited the GSA Web site, 63% found it very useful or useful, 26% found it somewhat useful, and 11% did not find it useful. Most respondents had not ordered GSA products on the Web site, although 29% indicated that they have purchased products via other Web sites.

What's Next

GSA's headquarters staff will use the results of the survey to develop new publications and other products for the membership and to enhance current publications. Changes in existing publications—e.g., a new table of contents for the *Bulletin* beginning with the July 1999 issue, and more frequent book reviews in *GSA Today*—are aimed at making GSA publications more relevant, accessible, and timely. ■

1995). A physical model for the mechanism of eruption has been proposed by Ivanov and Guliev (1988). In their model, ascending gas, traveling at twice the speed of sound, has the potential to suddenly compress when it encounters restrictions in its path, and therefore heat adiabatically. If the gas reaches a temperature of 537 °C, it will ignite and produce a potentially spectacular eruption. Large volumes of mud, breccia, and rock fragments are also associated with mud volcano eruptions, and several islands and shoals in the South Caspian Basin owe their origin to the accumulation of this erupted material.

Source Rocks

Organic-rich rocks of the Oligocene to lower Miocene Maikopian Series and the middle–upper Miocene Diatomaceous Suite constitute the principal oil-prone source rocks in the basin (Korchagina et al., 1988; Bailey et al., 1996). Based on analyses of samples from outcrop, core, and mud-volcano ejecta, Maikop source facies have total organic carbon contents up to 10%, hydrogen indices of 150–500 mg hydrocarbons/g organic carbon, and a predominance of marine algal organic matter (Guliev and Feizullayev, 1996; Abrams and Narimanov, 1997). Paleogeographic reconstructions of Oligocene and Miocene depositional environments indicate that source rock quality and organic richness should increase from more proximal onshore localities in the west to more distal, basinal settings in the area of the present-day South Caspian Basin. The ubiquitous nature of this source facies throughout much of the coastal and offshore regions of the South Caspian Basin is evidenced by prolific seepage of black oil. In their study of onshore seeps, Inan et al. (1997) correlated the geochemical signature of these oils with the Maikop source facies. Although the Maikop source facies has not been penetrated in the offshore, geochemical analyses of offshore oil seeps also can be correlated to the organic facies of the Maikop.

Burial History and Hydrocarbon Generation

The timing of oil and gas generation in the South Caspian Basin is greatly influenced by late Miocene–Holocene burial rates (up to 1.3 km/m.y.) and the resulting low temperature gradients of 14–16 °C/km (Bagir-Zadeh et al., 1988; Lubimova et al., 1974; Guliev et al., 1991; Bagirov et al., 1997). One-dimensional basin modeling based on the techniques of Lopatin (1971) indicates that the Neogene-Quaternary sedimentary succession is thermally immature for kerogen to oil conversion down to 6–8 km (Guliev et al., 1991). Given the low temperature gradient, the top of the oil window is interpreted to be near a depth of 8 km for Type II kerogens, and the base of the oil window and onset of gas generation is estimated at 13–14 km (Fig. 6; Bagirov et al., 1997). Basin modeling also suggests that the bulk of the oil was generated from Pliocene to

Caspian Basin *continued on p. 8*

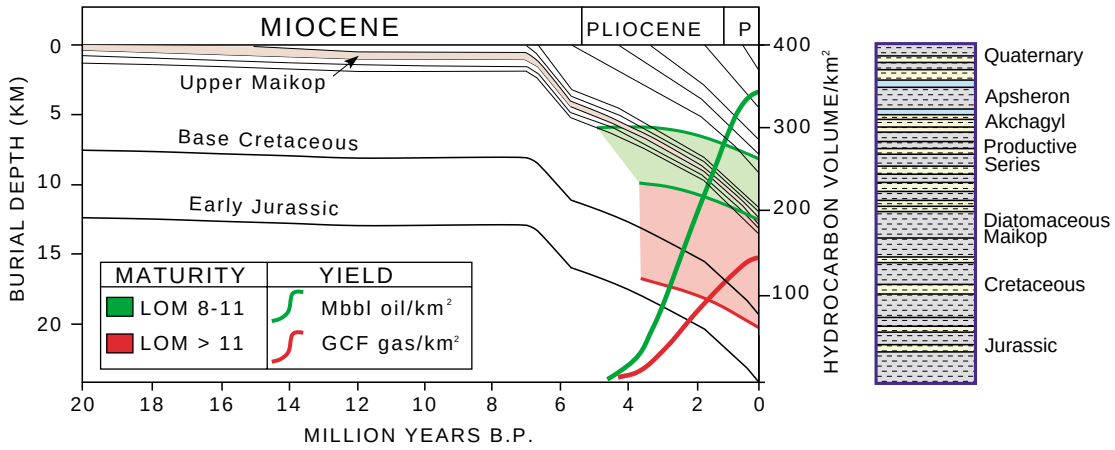

Figure 6. Burial history, hydrocarbon yields, and level of organic maturity (LOM) for an off-structure location in the central South Caspian Basin. The great depth for onset of hydrocarbon generation is due to the basin's low temperature gradients (~15 °C/km). Significant oil and gas yields from the Maikop began as recently as 4 Ma. LOM 8 and 11 correspond to a vitrinite reflectance equivalent of 0.55% and 1.1%, respectively.

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Quatenary time (Fig. 6; Narimanov, 1993), which is optimal timing relative to the onset of trap formation. The prolific present-day hydrocarbon seepage attests to active yields from the source rock and/or leakage from existing hydrocarbon traps.

Reservoir

Reservoirs in the upper Miocene–Pliocene Productive Series contain the vast majority of discovered hydrocarbons in the South Caspian Basin (Fig. 3). On the basis of outcrop studies, these strata are interpreted to have been deposited in nonmarine environments ranging from fluvial to lacustrine delta (Reynolds et al., 1998). From an exploration perspective, the most attractive reservoir targets occur in the lower Productive Series within amalgamated fluvial channel complexes of the Pereryva and lower Balakhany formations (Fig. 3). These reservoirs are mapped at depths between 4 and 7 km in undrilled offshore prospects. Fluvial deposits in the lower Productive Series below the Pereryva provide additional targets (Fig. 3).

The onset of Productive Series deposition represents a marked drop in relative base level. Reynolds et al. (1998) estimated that base level fell somewhere between 600 and 1500 m, and correlated the drop with the Messinian sea-level fall in the Mediterranean. In the late Miocene–Pliocene, the South Caspian Basin was a relatively small, isolated lake (Kerimov et al., 1991). Sediments were transported into the basin from the north by the paleo-Volga, from the west by the paleo-Kura, and from the east by the paleo-Uzboy river systems. North of the Apsheron Arch, in the central Caspian, the base-level drop caused the paleo-Volga River to incise a deep canyon that was subsequently onlapped by Productive Series strata (Kerimov et al., 1991; Mamedov, 1991).

As in all basins, sequence architecture and stratal stacking patterns reflect the interplay of tectonics, base-level changes, and sediment supply. For the South Caspian Basin, these factors consisted of subsidence, episodic uplift of surrounding orogens, lake-level changes, and sediment supply from the three river systems mentioned above. In addition, glacially induced climate changes are interpreted to have played an important role in controlling lake level and sediment supply and, consequently, reservoir distribution (Kerimov et al., 1991).

CONCLUSIONS

A combination of a unique geologic development, a prolific hydrocarbon system, and a benchmark chapter in the history of petroleum exploration characterizes the South Caspian Basin. In much of the region, the political climate for foreign investment is very favorable and, consequently, exploration activities that include the acquisition of 3-D seismic surveys and exploration drilling proceeds apace. With all of this focused interest and resulting activity, we should know soon whether the South Caspian Basin will live up to its promise.

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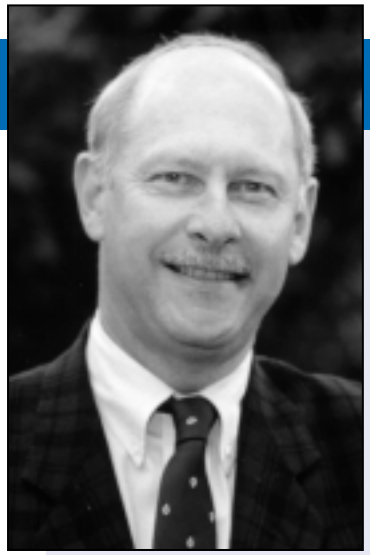

Captain of GSA Enterprise Retires

Five years and one strategic plan after taking the helm at GSA headquarters, Donald M. Davidson, Jr. has retired from the executive director position, effective June 30, 1999.

Davidson came to GSA headquarters from an administrative position at Northern Illinois University. He vied with several other candidates for the GSA executive director post. His successor is Sara S. Foland, chosen in May by the GSA Council.

Davidson said that his original goals for the directorship included growth of the membership, development of a straightforward business approach to running GSA, and fostering of a team-oriented atmosphere at headquarters, with emphasis on member service. In assessing progress in these areas, he noted that the membership of GSA has grown 7%; that effective budgeting and budget-monitoring processes are now in place; and that the headquarters staff cooperate with each other more closely than previously and have recently received high member-service ratings in a survey by the Council on Engineering and Scientific Society Executives. Davidson is particularly pleased that GSA now has a strategic plan, a map for the future.

Commenting on Davidson's contributions, 1998 GSA President Victor Baker said, "Don came to GSA at a pivotal time in its history. This was a period of transition, especially at headquarters, from practices that had served the Society in the past, but were becoming incompatible with the complexity of the operation in the 1990s. Don brought about an organization of headquarters that now allows it to implement that other major accomplishment of his regime: the strategic plan. The plan has engaged both the membership and headquarters in a new partnership. The progress of the future will be built upon the sound structure made possible during Don's tenure."

Ed Geary, director of GSA education programs, echoed Baker's comment. "One of the chief accomplishments of Don's tenure at GSA is our new strategic plan," Geary said. "Starting from scratch and helping us through the tortuous first phase of development, Don brought together leadership, staff, and members to craft a document that will help to guide our efforts during the next decade."

Speaking from a headquarters staff perspective, Geary added, "During the past five years, Don has created a more open environment at GSA and encouraged us to communicate more broadly across departments. I think all of us are now more knowledgeable about GSA's mission, budget, and day-to-day operations."

Davidson said that he plans to stay active in geoscience associations, particularly the Society of Economic Geologists and GSA. He and his wife, Mary, will remain in the Boulder area.