Neogene Stratigraphic Development of the Persian Gulf

Stephen A. Swift and David A. Ross
Dept. of Geology and Geophysics
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
Swift: phone: 508-289-2626 fax: 508-457-2150 email: sswift@whoi.edu
Ross: phone: 508-289-2578 fax: 508-457-2187 email: dross@whoi.edu
Award #: N00014-96-1-0548 and N00014-97-1-0410

LONG TERM GOAL

The Persian Gulf is a shallow (<110 m), epicontinental basin formed on the Arabian plate in mid-late Miocene. Neogene sediments comprise a northeast-thickening wedge (0.1-2.0 km) of clastics shed from the Zagros uplift in Iran. There is little publicly available information on these deposits. Our long-term goal is to understand how variations in source, tectonic subsidence, climate, and sea level affected sedimentary processes and stratigraphic development of an arid, shallow-marine environment.

OBJECTIVES

The initial objective of this project is to define the broad lateral and temporal patterns in late Cenozoic stratigraphy in the basin. Our objectives also include mapping Quaternary channels, deltas, and sequence stratigraphy across the entire basin and correlating these to wells and surface sediment cores. These data will be used to test our hypothesis that wet-dry cycles in climate are as important to channel and sediment sequence development as sealevel change. We will also investigate the age and origin of linear seafloor microtopography at the head of the Gulf and in the Straits of Hormuz.

APPROACH

The initial objective was addressed with award N00014-96-1-0548 and consisted of a study of existing industry data. We purchased logs for 25 Iranian wells in the Gulf and paper copies of ~5,000 km of multi-fold industry seismic profiles from Masera Corp. Based on area covered, 50-60% of the seismic profiles are of such low quality in the Cenozoic section (upper 0.5-0.9 sec) that it is difficult to recognize reflectors much less unconformities. In addition to the Masera data, we used seismic profiles from an *R/V Atlantis II* cruise in 1977 and published formation tops for 17 additional wells in the Gulf and Iran and 12 wells in Iraq.

We are re-examining the stratigraphy of sediment cores obtained from the *R/V Atlantis II* . We obtained accelerator mass spectrometer radiocarbon ages for significant lithologic boundaries. We also systematically sampled the stratigraphy in a 4 m piston core taken from one of the Holocene river deltas off Iran.

Given the deficiencies in the existing data bases for the Gulf, the remaining objectives were addressed with a field program during which we collected additional sediment cores, high-frequency subbottom profiles, and high-resolution multichannel seismic profiles under separate funding (N00014-97-0410).

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Neogene Stratigraphic Development of the Persian Gulf	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Woods Hole Oceanographic Institution,Department of Geology and Geophysics,Woods Hole,MA,02543**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002252.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**3**	

This survey covered as much of the Gulf as possible given the restrictions that shallow water, oil fields and territorial limits have on ship operations. The approach was to seismically map Neogene stratigraphy and tie this structure to dated surface sediment cores and industry wells where possible. The survey is a joint operation between WHOI and NAVOCEANO.

WORK COMPLETED

Mapping of the central Persian Gulf based on industry data is completed. I mapped three unconformities, correlated unconformities to well geology, and merged picks with navigation and velocity data to produce depth-to-horizon maps. I compiled these results with published geologic datums from wells on land, prepared figures merging the well sonic logs with seismic reflection profiles, and published the results as a WHOI Technical Memorandum (Swift et al., 1998).

We completed the follow-up field surveys from the *USNS Bowditch* during July and August collecting 2422 nmi of seismic profiles and 34 successful sonobuoy profiles out of 48 deployed. Swath bathymetry, XBTs, and 3.5 kHz subbottom reflection profiles were recorded. NAVOCEANO also collected 40 cores, CTD profiles, XBT casts and additional 3.5 kHz profiles which are being transferred to WHOI.

RESULTS

Mapping based on the industry seismic profiles and well data indicates higher rates of subsidence along the Iranian coast of the Gulf than along the Arabian side (Swift et al., 1998; Uchupi et al., submitted) but could not resolve systematic patterns that would indicate changes in sealevel or lateral variations in sediment supply.

Our studies of surface sediment cores (Uchupi et al., submitted) suggest that the Gulf was an arid basin during the Wisconsin sealevel lowstand 18,000-20,000 yr ago. Post-glacial sedimentation was most rapid in deltas that extend southeastward off Iranian rivers. Most of the radiocarbon dates plot below both the eustatic sealevel curve and a local sealevel curve predicted for the Gulf by Lambeck. This discrepancy suggests subsidence rates of 1-2 mm/yr which contradicts previous claims that the seafloor is tectonically stable.

Quick-look plots of near-trace multichannel profiles made at sea in August indicate at least two new features of the stratigraphy in the Persian Gulf. A complete analysis of the cruise results will done after arrival of the multichannel tape and paper records being shipped from NAVOCEANO. In the central and northern Gulf, reflections dip downward towards the northeast (Iran). This structure was well-known before our cruise, but there was no well-substantiated explanation. A similar structure appears in north-south profiles located in the western approach to the Straits of Hormuz. The similarity in structure strongly suggests that it is thickening of the continental crust by gravity slide folding in the Zagros Mountains of Iran that is the driving force for rapid subsidence near Iran rather than compression of the Arabian plate. Along the Iranian side of the Gulf, seismic and 3.5 kHz profiles show 2-3 channels cut into Pleistocene deposits and subsequently filled by later sediment. These channels appear to extend from Laven Island (53°E, 26.8°N) north to about 28.5°N. These examples illustrate the quality of the single-channel data collected and suggest that the stacked multichannel profiles will give clear pictures of both the regional tectonic-driven structure and the small-scale erosional features of the basin.

IMPACT/APPLICATIONS

The deepening of the late Cenozoic horizons towards Iran and systematically depressed radiocarbon ages for Holocene sediment reflect tectonic subsidence driven by the shifting sedimentary load on the Arabian plate due to the southwestward sliding of the Zargos Fold Belt along a deep salt layer. The shallowing of Cenozoic datums across the northern end of the Persian Gulf indicates that tectonic subsidence in the Mesopotamian valley of Iraq is slower than subsidence in the Persian Gulf. The response of the Persian Gulf basin to climate and sealevel changes in the Pleistocene is unclear. Shallow seismic data indicate that fluvial channels off Iranian rivers were eroded and subsequently filled indicating wet conditions during one of the Pleistocene low sealevel stands, but cores analyzed to date suggest an arid, waterless basin during the lowstand at 18,000 yrs ago.

TRANSITIONS

One of the primary objectives of the analysis phase following our 1998 cruise will be to obtain interval velocities from multi-channel semblance data. These will be compared to refraction velocities from the sonobuoys determined by J. Diebold at LDEO, to the Masera well velocities, and to acoustic velocities measured in sediment cores by NAVOCEANO. These data will provide direct, systematic measurements of seafloor velocity data base for Navy operations in the Persian Gulf. Another objective of the regional mapping will be to determine the location and depth of sub-seafloor channels. The digital 3.5 kHz data collected will be replotted and used to examine the nature and origins of seafloor micro-topography in the Straits of Hormuz.

RELATED PRODUCTS

The high-resolution seismic and seafloor mapping study will provide an arid environment end-member to the STARTIFORM field studies.

Amy Bower (WHOI PO) has studied Persian Gulf bottom water outflow using Navoceano AXBTs. We hope the water column data from the *USNS Bowditch* cruises will be made available to Bower, so we can collaborate on studying the effects of bottom water flow on sediment transport.

REFERENCES

Uchupi, E., S.A. Swift, D.A. Ross, submitted, Late Quaternary stratigraphy: paleoclimatology and neotectonism of the Persian (Arabian) Gulf region, Marine Geology.

S.A. Swift, E. Uchupi, and D.A. Ross, 1998, Late Cenozoic geology of the central Persian (Arabian) Gulf from industry well data and seismic profiles, WHOI Technical Memorandum 01-98, April, 1998, 75 pp.