Landsat Exploration of Unayzah Trend, Saudi Arabia*

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Abstract

In the late 1980s Saudi Aramco requested Chevron to process and interpret Landsat TM images of the unexplored Central Arabian Arch, which is a vast homocline with regional dips of 1° to 2° and no closed surface structures. The giant fields in the Retained Areas are drape anticlines with very gentle dips that overlie basement faults. We developed a 3-D model illustrating how such structures might be expressed on images of the Arch. We used the model to recognize a number of anomalies on the Landsat images of the Central Arabian Arch. We then checked the anomalies in the field. Next, Aramco conducted seismic surveys that confirmed the model concept. In 1989 the Raghib and Dilam fields were discovered on anomalies that are almost 100 km from the nearest fields. The Unayzah Sandstone (Pennsylvanian and Permian) reservoir produces light, sweet oil, in contrast to the heavy, sour oil of the Arab D (Jurassic) of the Retained Areas. The organic-rich Qusaiba Shale (Silurian) is the source of the oil which migrated upward along the faults that underlie the anticlines. Exploration of other Landsat anomalies was interrupted by Desert Storm, but resumed with several additional discoveries along the "Unayzah Trend".

Reference

McGillivray J.G., and M.I. Husseini, 1992, The Palaeozoic petroleum geology of Central Arabia: AAPG Bulletin v.76, no. 10, p. 1473-1490.


LANDSAT EXPLORATION OF
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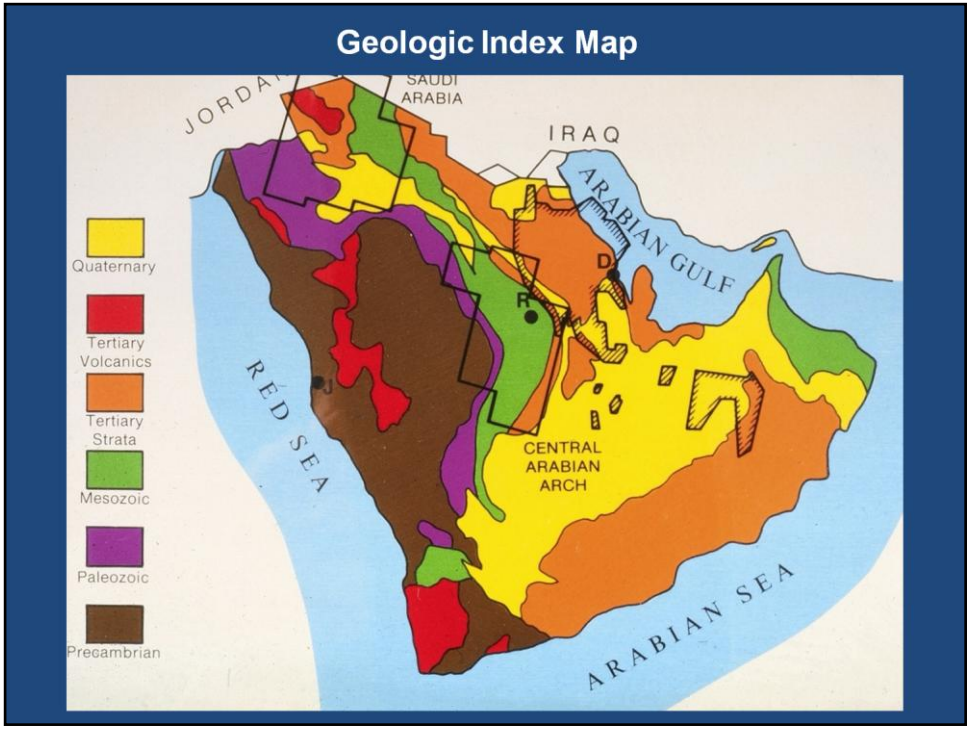
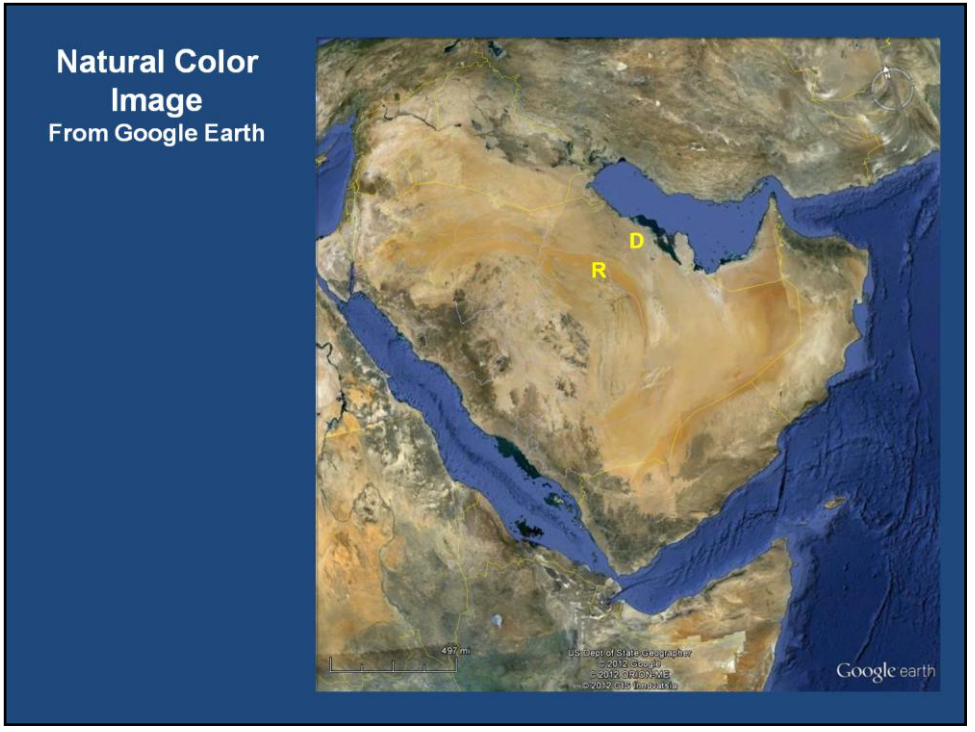
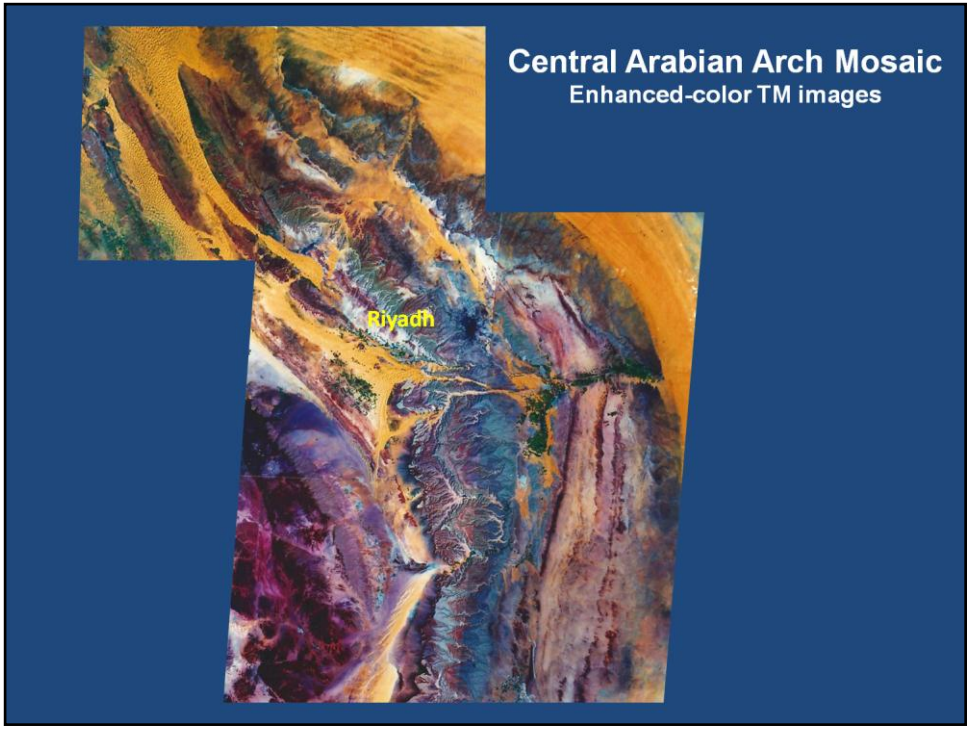


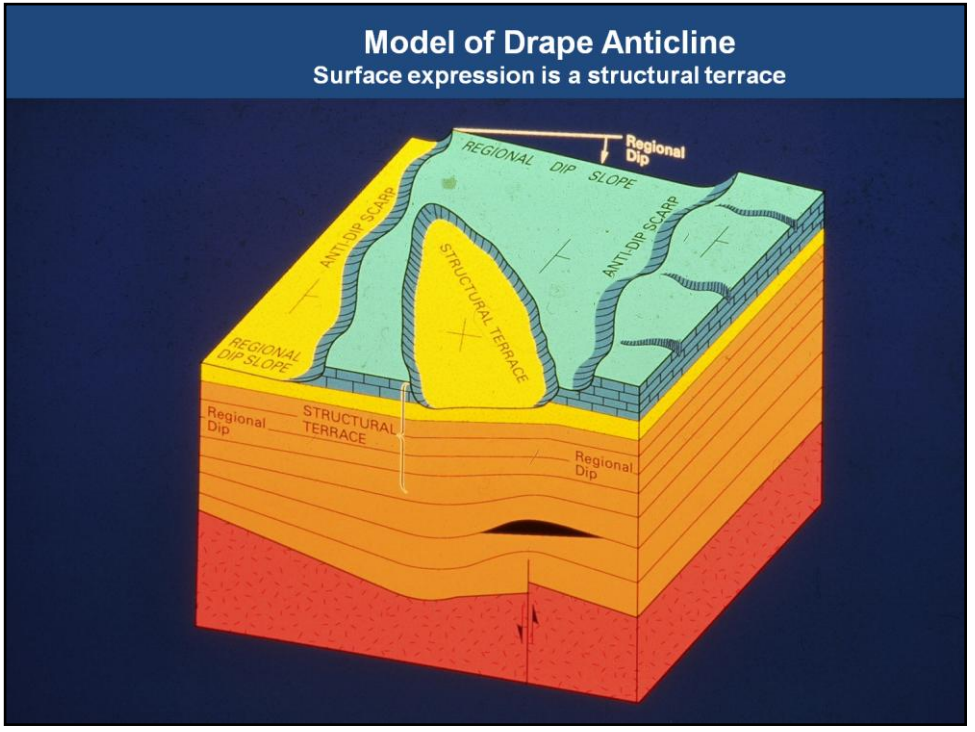
Presenter's notes: Index map of Arabian peninsula. Hachured outlines – Retained areas where exploration was confined until late 1980s. D - Dharan and Dammam Dome (first Saudi oil discovery). R – Riyadh, Saudi capitol. Note location of Central Arabian Arch project.



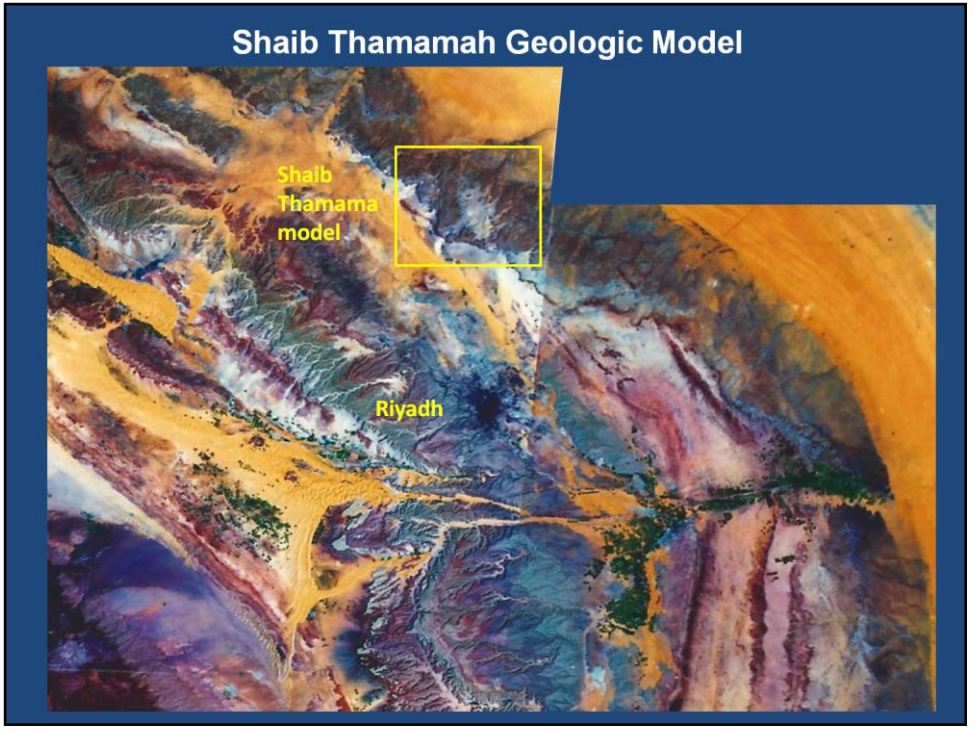
Presenter's notes: Google Earth true color image of Arabian peninsula. D- Dharahn and Dammam dome.



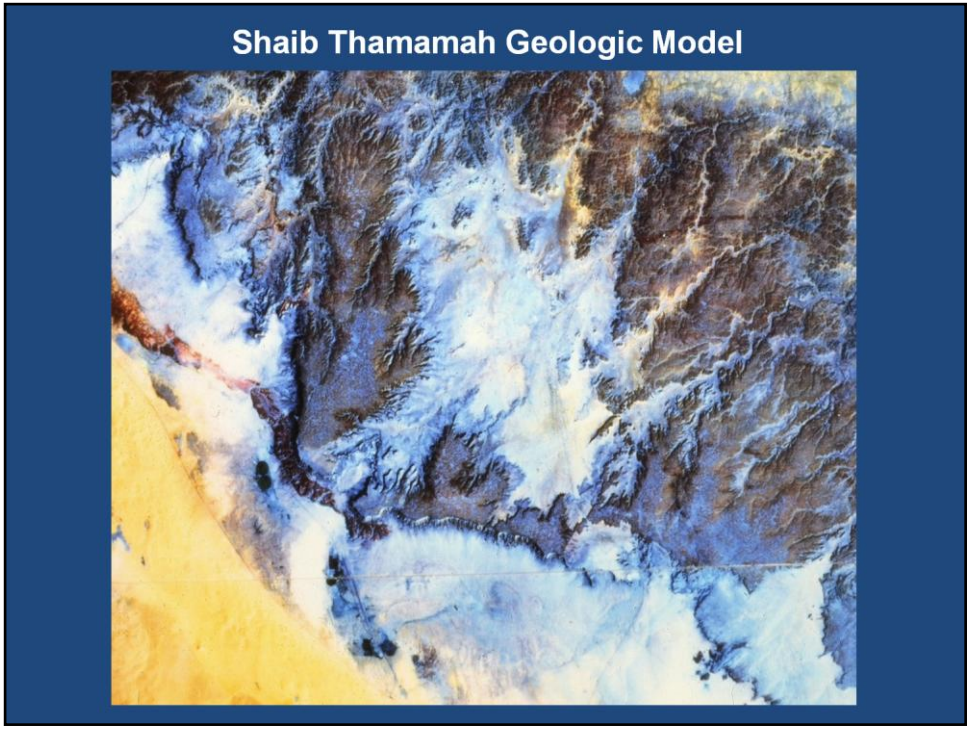
Presenter's notes: Central Arabian Arch project area. Enhanced color Landsat TM mosaic. Note very gentle NE and E dip (1 to 2 degrees) of outcrops. >200,000 km^2



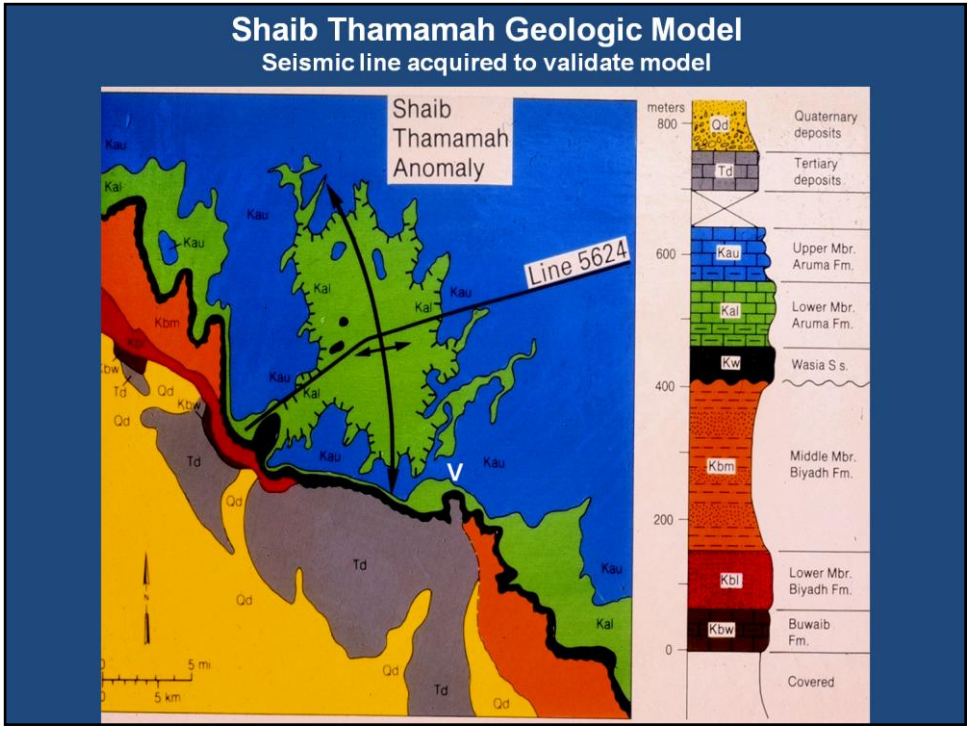
Presenter's notes: Model of fault-controlled anticlines that migrate upward into structural terraces with geomorphic expression.



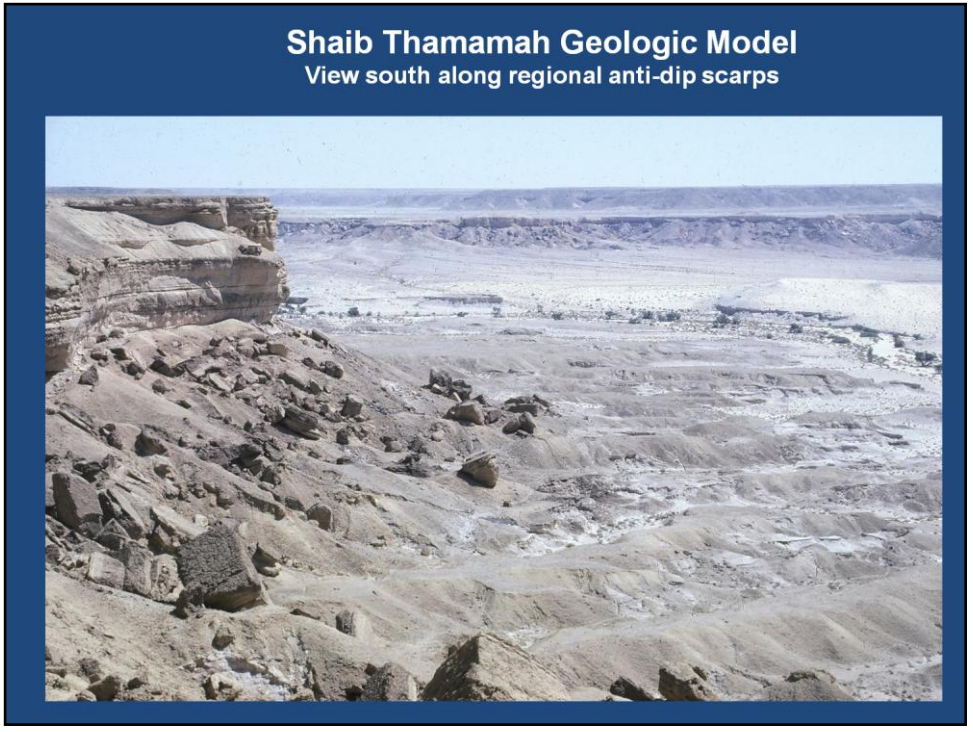
Presenter's notes: Central Arabian Arch index image. Note northwestward truncation at base of mid-Cretaceous unconformity.



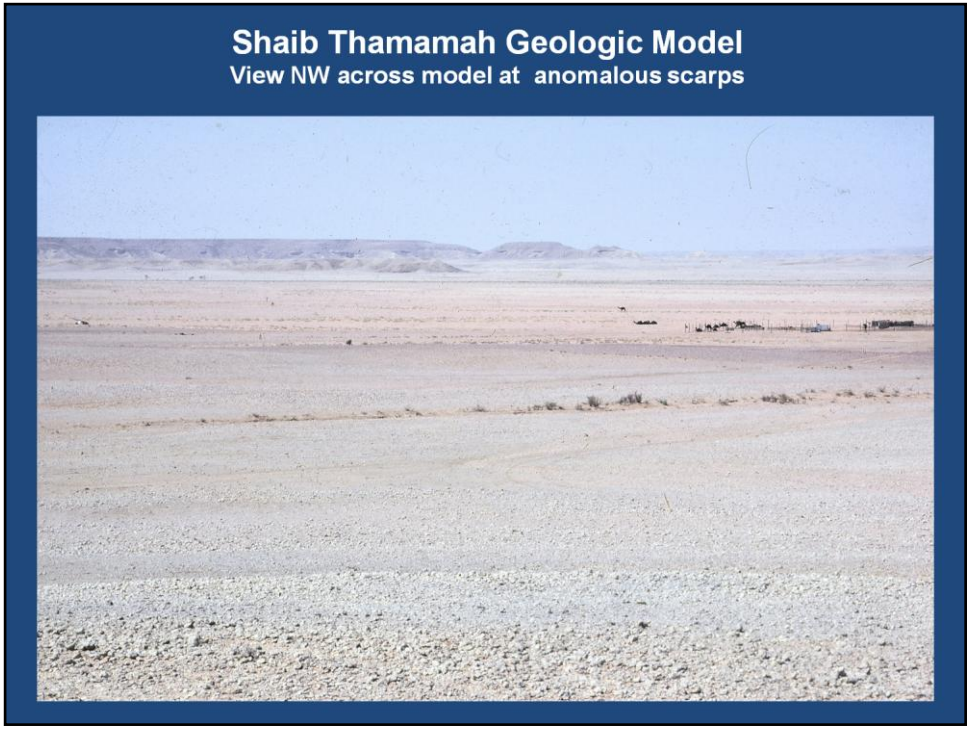
Presenter's notes: Shaib Thamamah anomaly. Gently NE-dipping Upper Member of Aruma Fm. (dark signature) is warped into a structural terrace that is eroded to expose the Lower Member (bright signature).



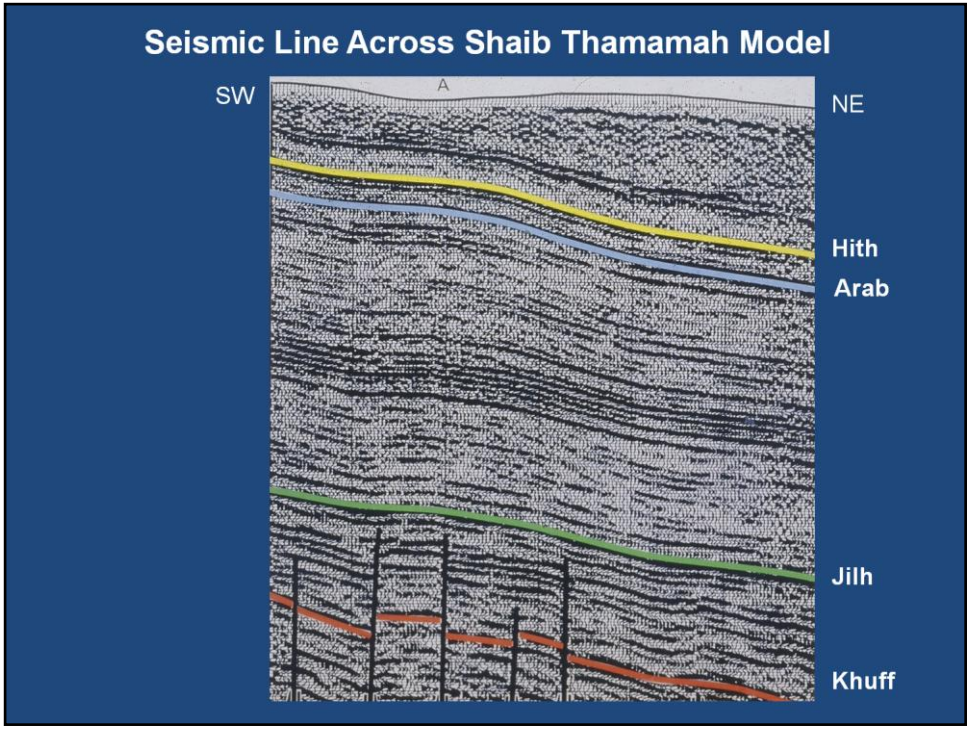
Presenter's notes: Shaib Thamamah map showing seismic line 5624 that Saudi Aramco acquired to test the geologic model.



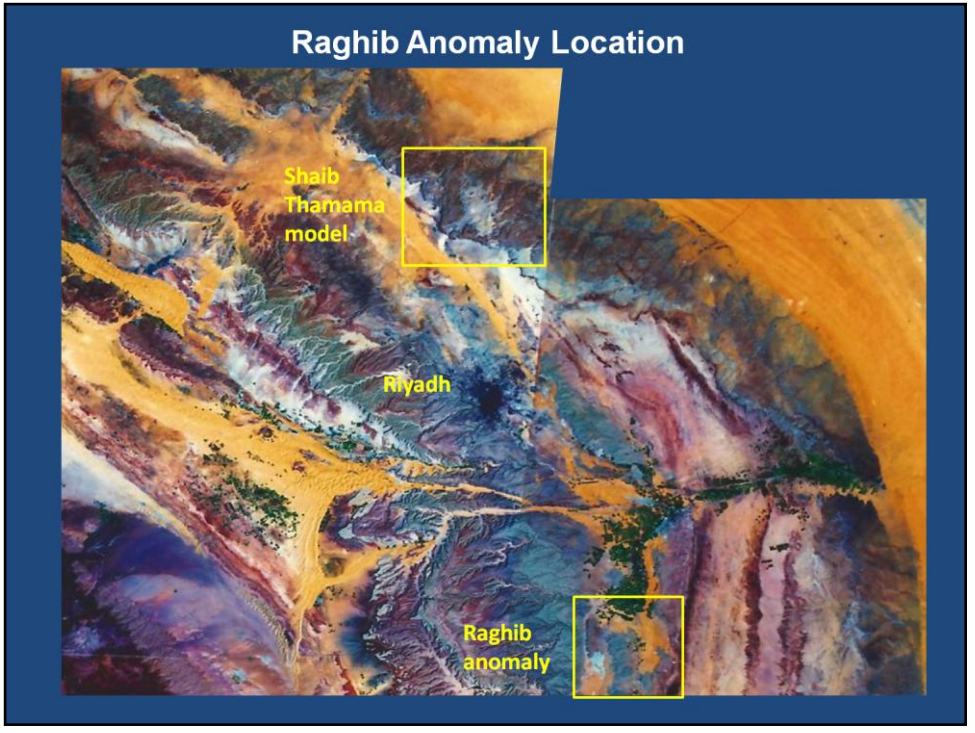
Presenter's notes: View along south margin of Shaib Thamamah anomaly showing regional anti-dip scarps of Aruma Fm.



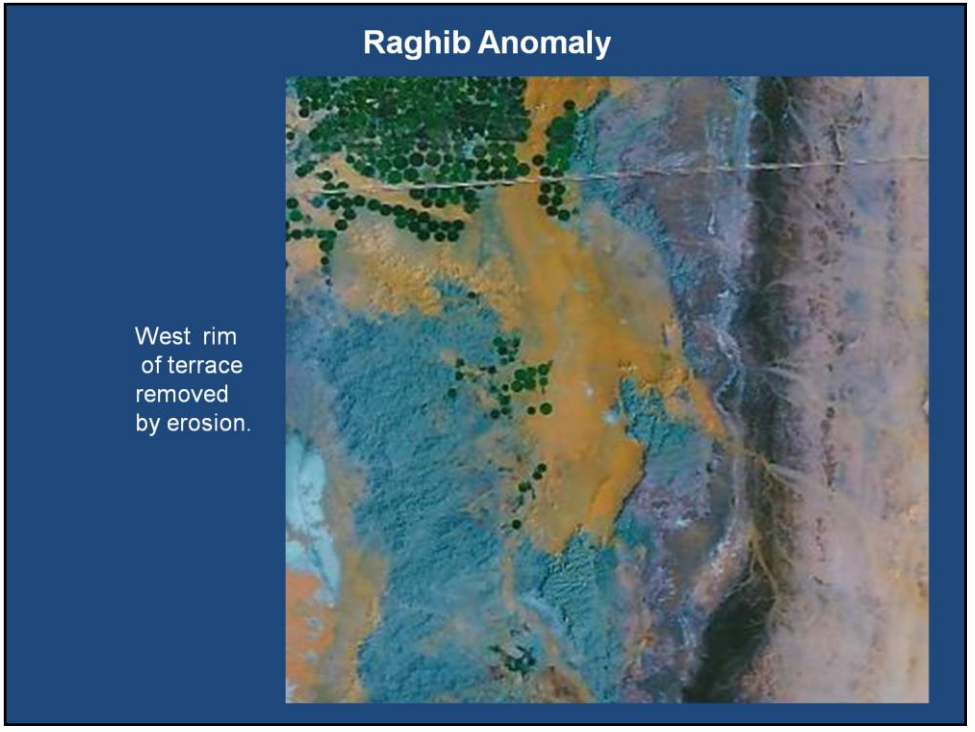
Presenter's notes: View looking north atShaib Thamamah anomaly which is a depression floored with nonresistant Lower Member of Aruma Fm. In the distance are anomalous NE-facing scarps of Upper Member of Aruma Fm.



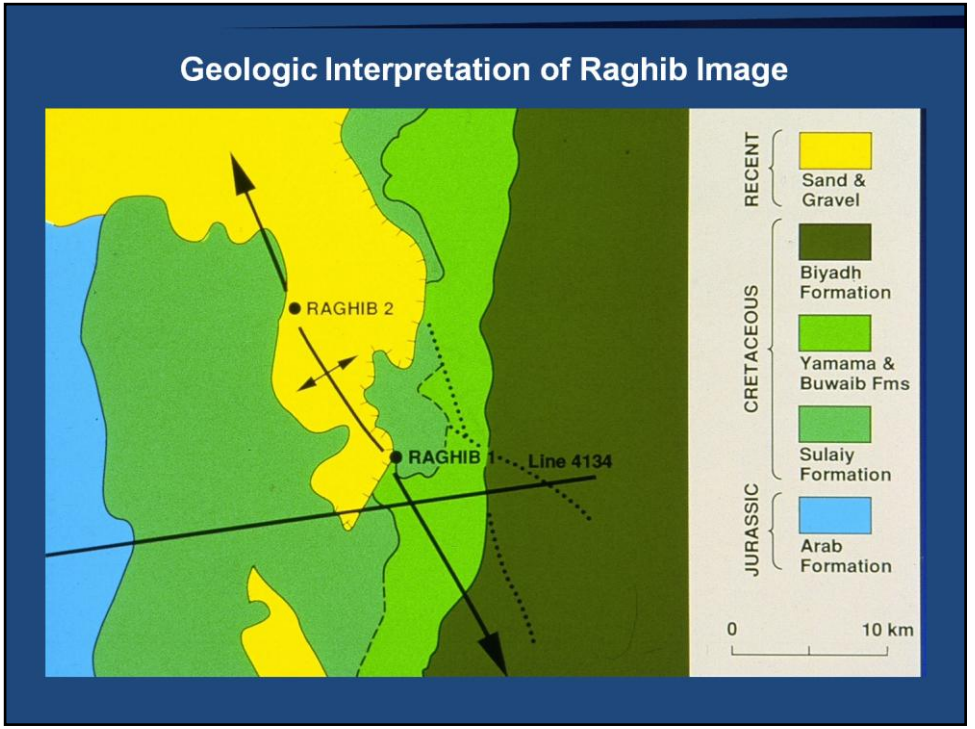
Presenter's notes: Line 5624 across S T anomaly. Regional NE dip is interrupted by structural terrace overlying basement faults. The five faults account for the large extent of the anomaly.



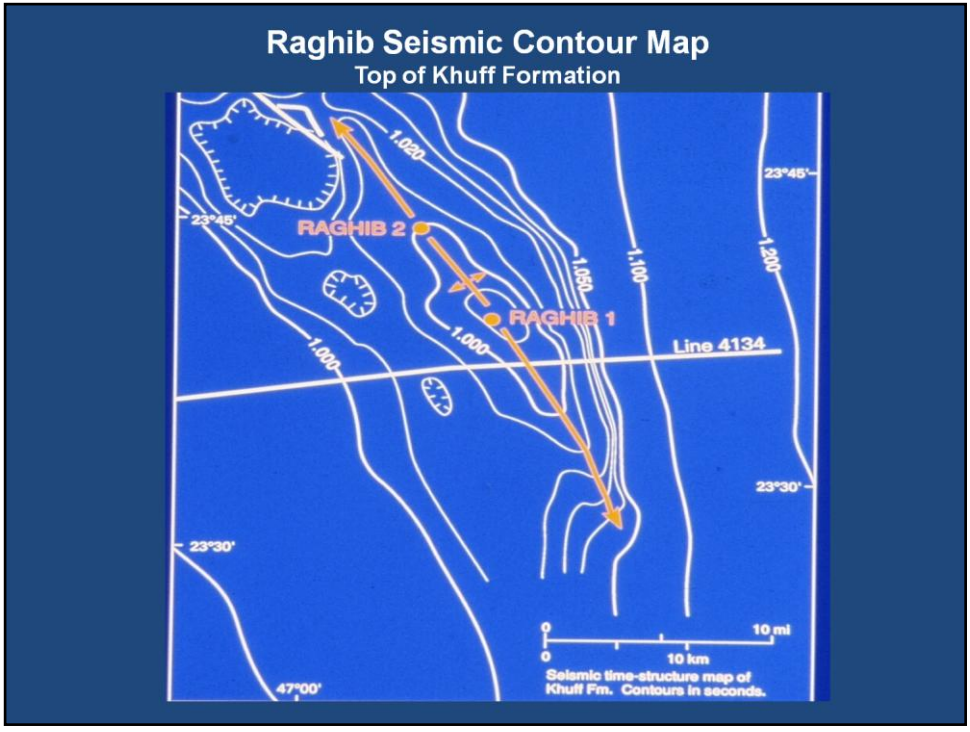
Presenter's notes: Central Arabian Arch index image showing location of Raghib anomaly.



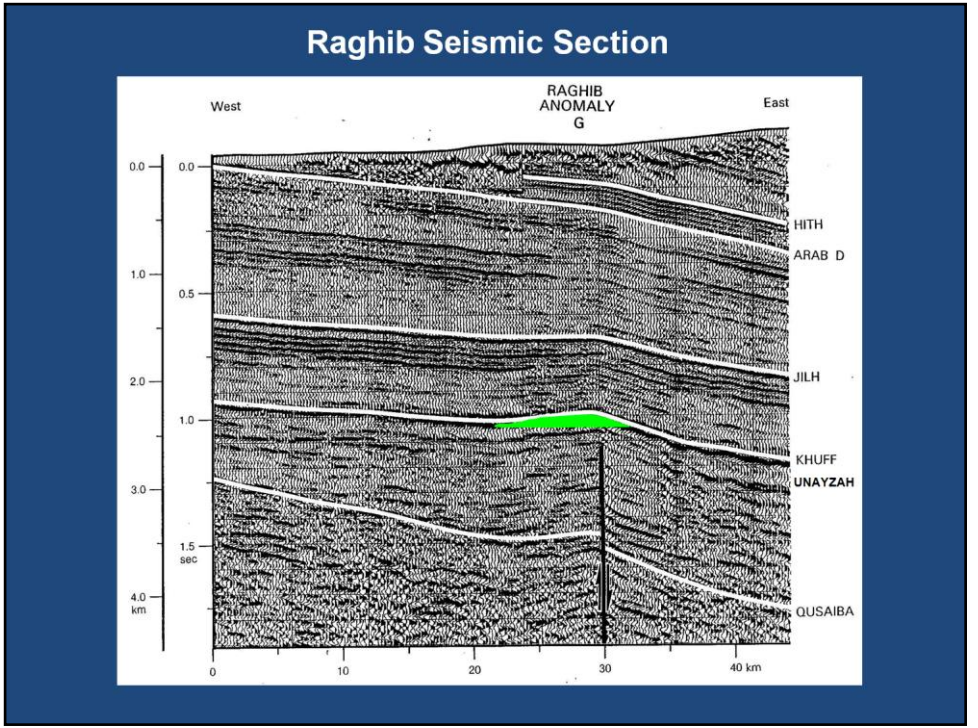
Presenter's notes: Image of Raghib anomaly that is an eroded structural terrace within gently east-dipping strata. Anomaly is mantledby windblown sand with yellow signature.



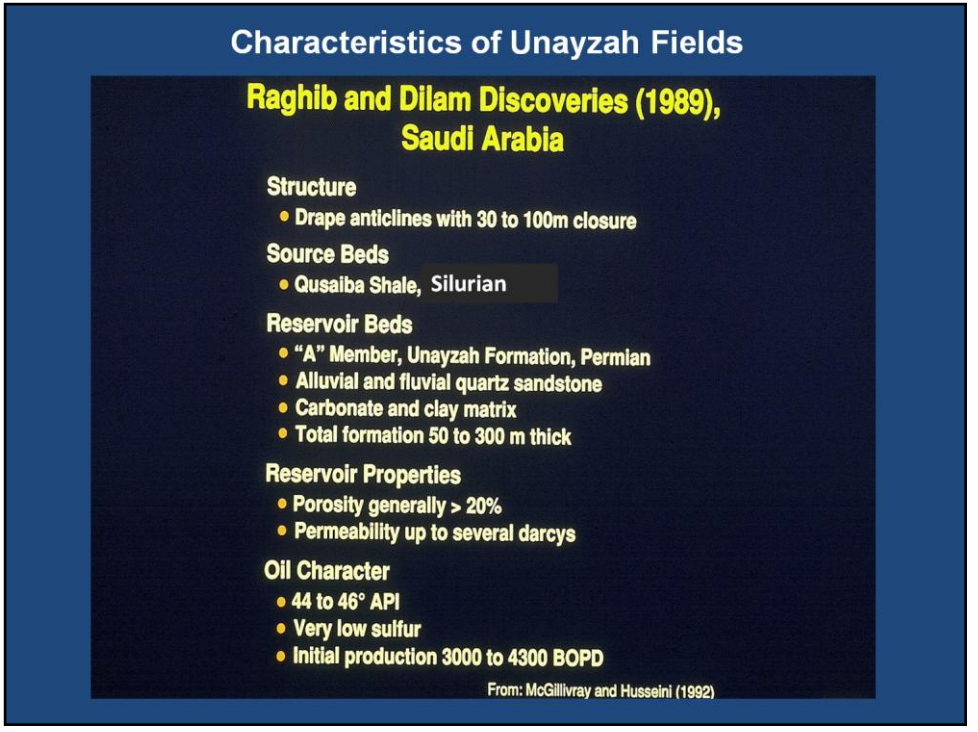
Presenter's notes: Geologic interpretation of Raghib image. Raghib 1 and 2 are discovery and confirmation wells. Note location of seismic line 4134.



Presenter's notes: Seismic contours (seconds) on top of Khuff Limestone that overlies the Unayzah reservoir sandstone.

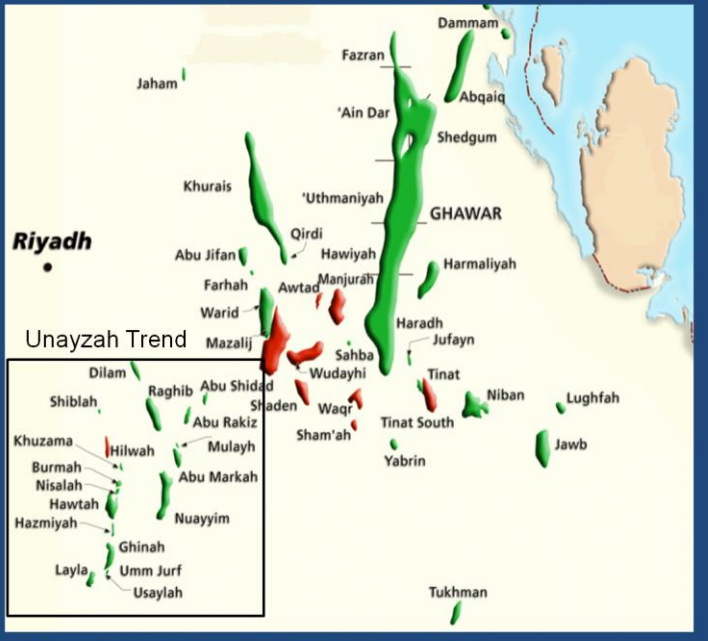


Presenter's notes: Seismic line 4134 across Raghib field which is a drape anticline above a basement fault. Oil from the Qusaiba (Silurian) source rock migrated up the fault and was trapped in the Unayzah Sandstone (Permian), which is sealed by the impermeable Khuff Limestone (Permian).

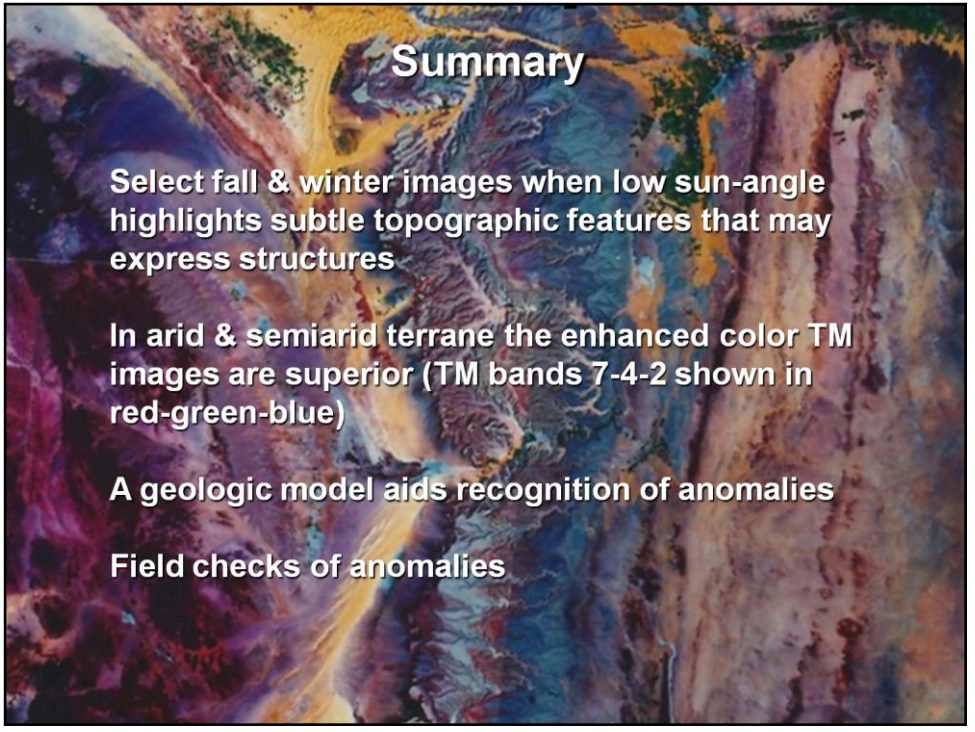


Presenter's notes: Characteristics of high gravity, low sulfur Unayzah oil, which differs from low gravity, high sulfur Arab D (Jurassic) oil.

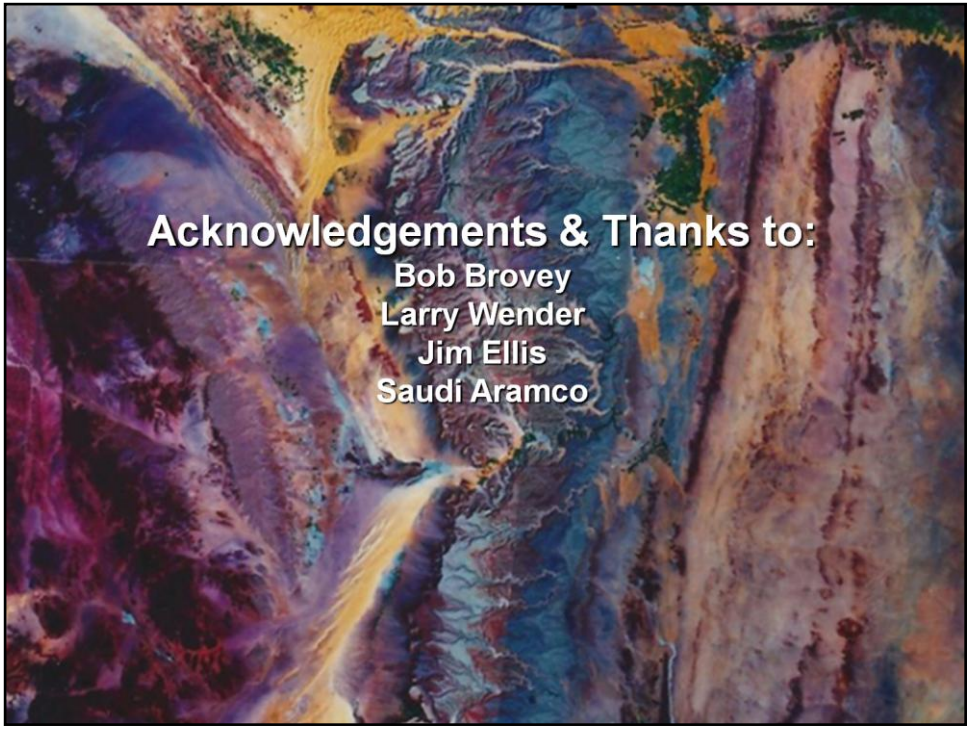
Shaib Thamamah Geologic Model



Source: http://205.254.135.24/EMEU/cabs/Saudi_Arabia/images/Oil%20Gas%20Fields%20Map.gif

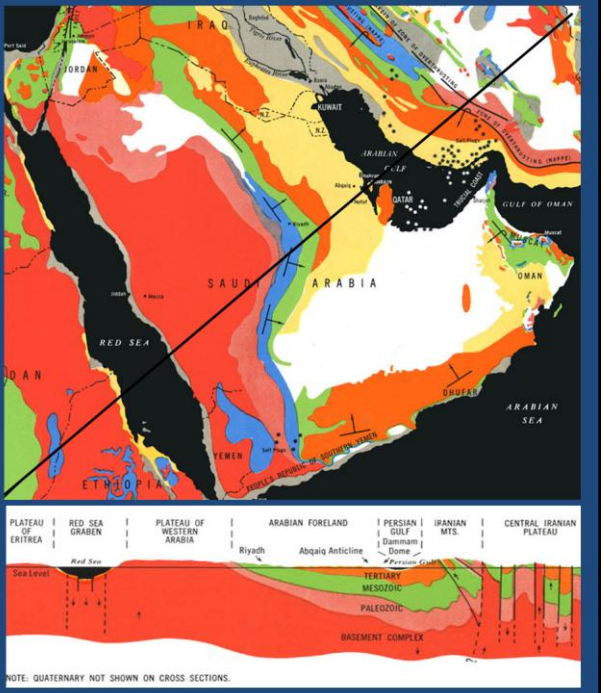


Presenter's notes: Summary.



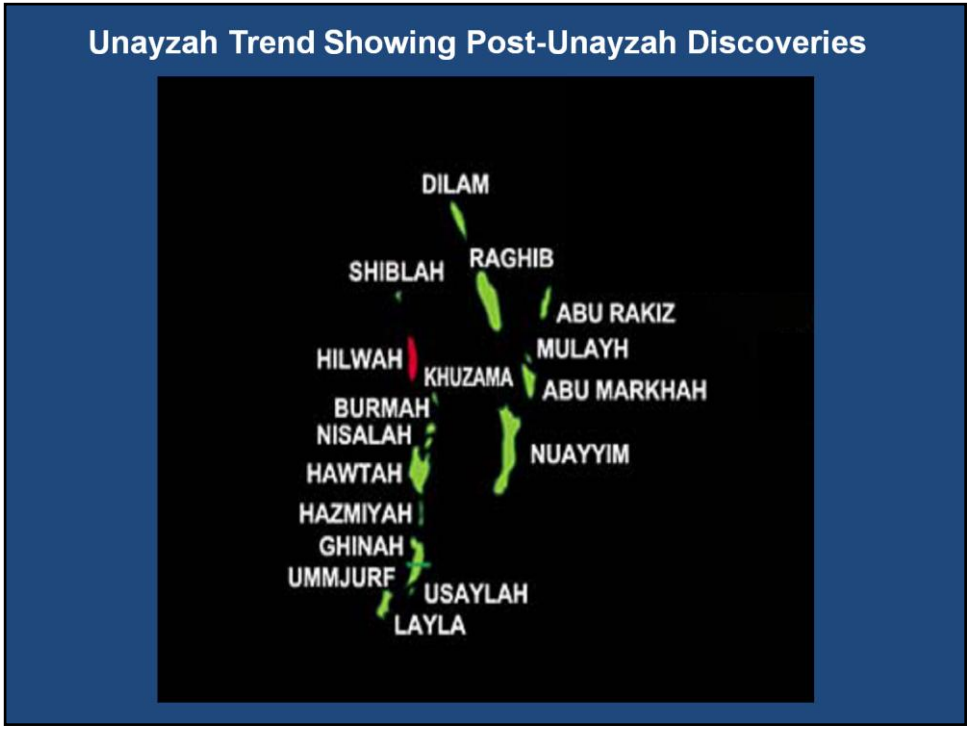
Presenter's notes: Summary.

Regional Geologic Map with Northeast-Southwest Cross Section

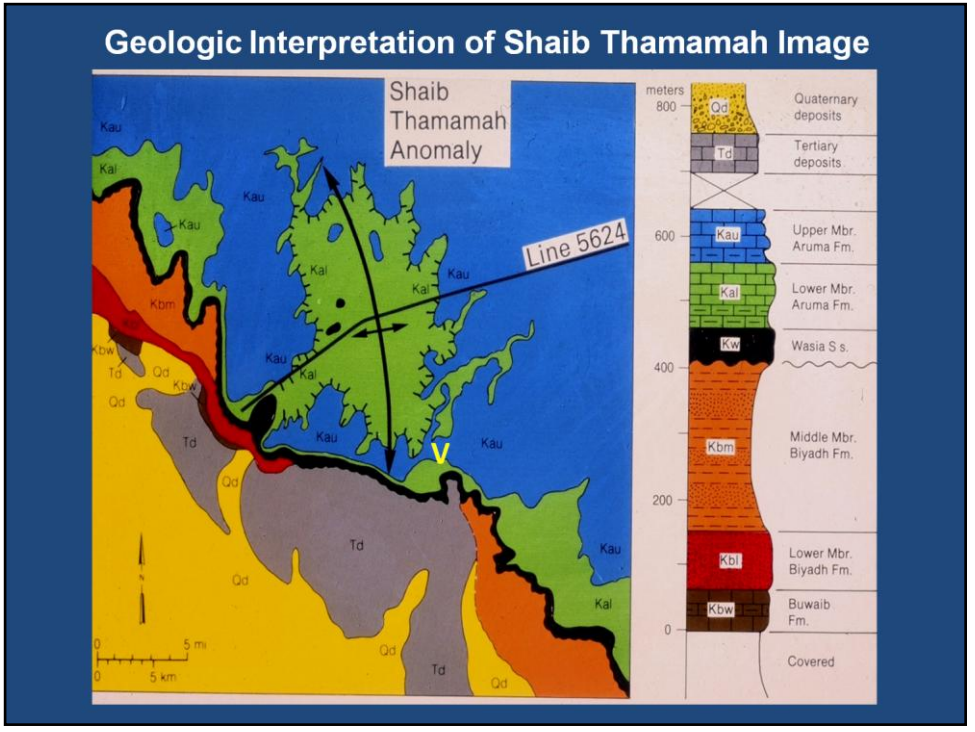


Source: http://codex99.com/cartography/images/saudi_geology_lg.jpg

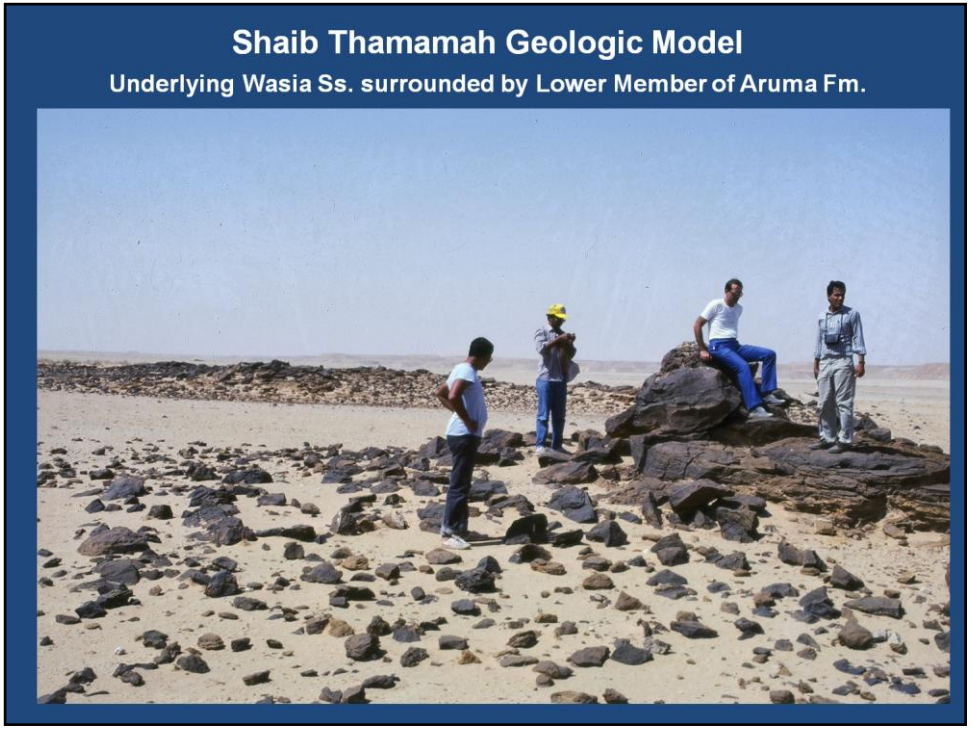
Source: http://205.254.135.24/EMEU/cabs/Saudi_Arabia/images/Oil%20Gas%20Fields%20Map.gif



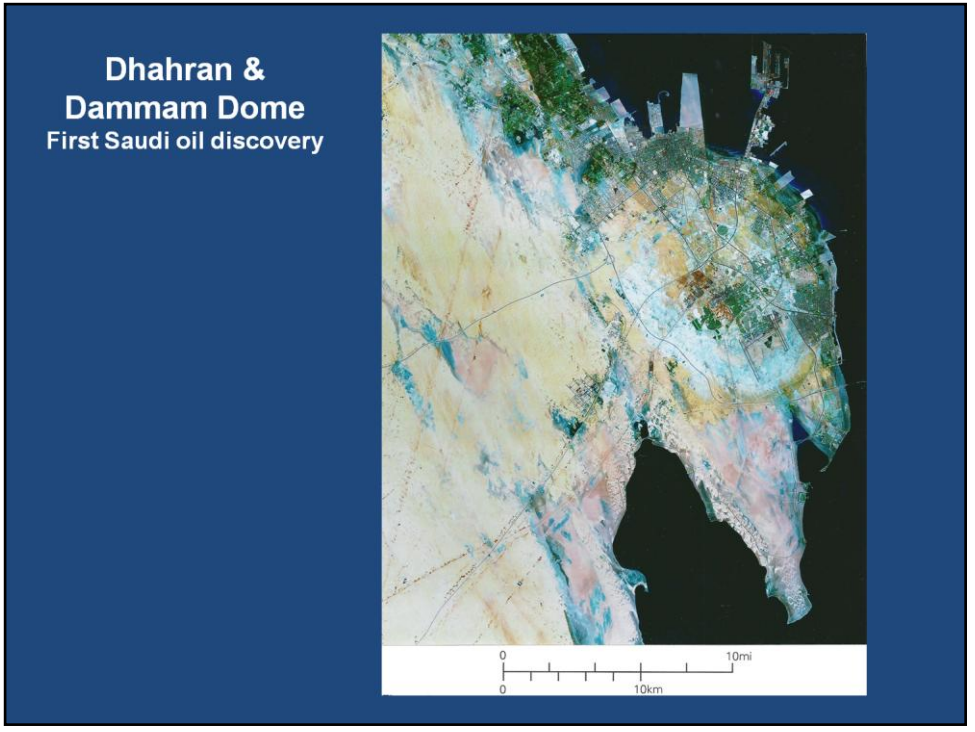
Presenter's notes: New oil fields (post-Raghib discovery) in Unayzah Trend. A number of Landsat anomalies are in the trend. However, we lack coordinates of the fields and cannot evaluate any comparisons.



Presenter's notes: Geologic interpretation of Shaib Thamamah image. Within the anomaly note outcrops of Wasia Sandstone surrounded by Lower Aruma Member. V – Viewpoint for photos.



Presenter's notes: Outcrops of Wasia Sandstone surrounded by overlying Lower Member of Aruma Fm within Shaib Thamamah anomaly.



Presenter's notes: Landsat thematic mapper image of Dharan and Dammam Dome where Standard Oil of California (Chevron) discovered first oil in Saudi Arabia