Monday, October 19, 2009

Westchase Hilton • 9999 Westheimer
Social Hour 5:30-6:30 p.m. • Dinner 6:30-7:30 p.m.

Cost: $28 pre-registered members; $35 for non-members & walk-ups;

To guarantee a seat, you must pre-register on the HGS website and pre-pay with a credit card.

Pre-registration without payment will not be accepted.
You may still walk up and pay at the door, if extra seats are available.

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Sub-aerial Basins Below Sea Level Provide Unexpected Reservoirs

Throughout geologic history there have been large sub-aerial basins below sea level. There are two times in the plate tectonic cycle when such basins are likely to form: during the rifting of cratons and when old basins are sealed off during collisions. Examples of the former include the Afar at 410 feet below mean sea level, the southern North Sea at 750 ft bmsl, and the South Atlantic basins. Examples of the latter include the Mediterranean during Messinian time at 10,000 ft bmsl, the Black Sea at 550 ft bmsl, and the Gulf of Mexico during deposition of the Jurassic Norphlet sands and perhaps the Paleocene Wilcox sands at ~6,000 ft bmsl (in shallow water to sub-aerial).

The presence of sub-aerial sediments does not necessarily mean basin uplift!

Basins that were below sea level but sub-aerial influenced sedimentation and should influence the interpretation of their tectonic histories. The presence of sub-aerial sediments does not necessarily mean basin uplift!

A desiccated sub-aerial basin below sea level may have been the site of extensive desert deposits. Winds pouring across the lip and

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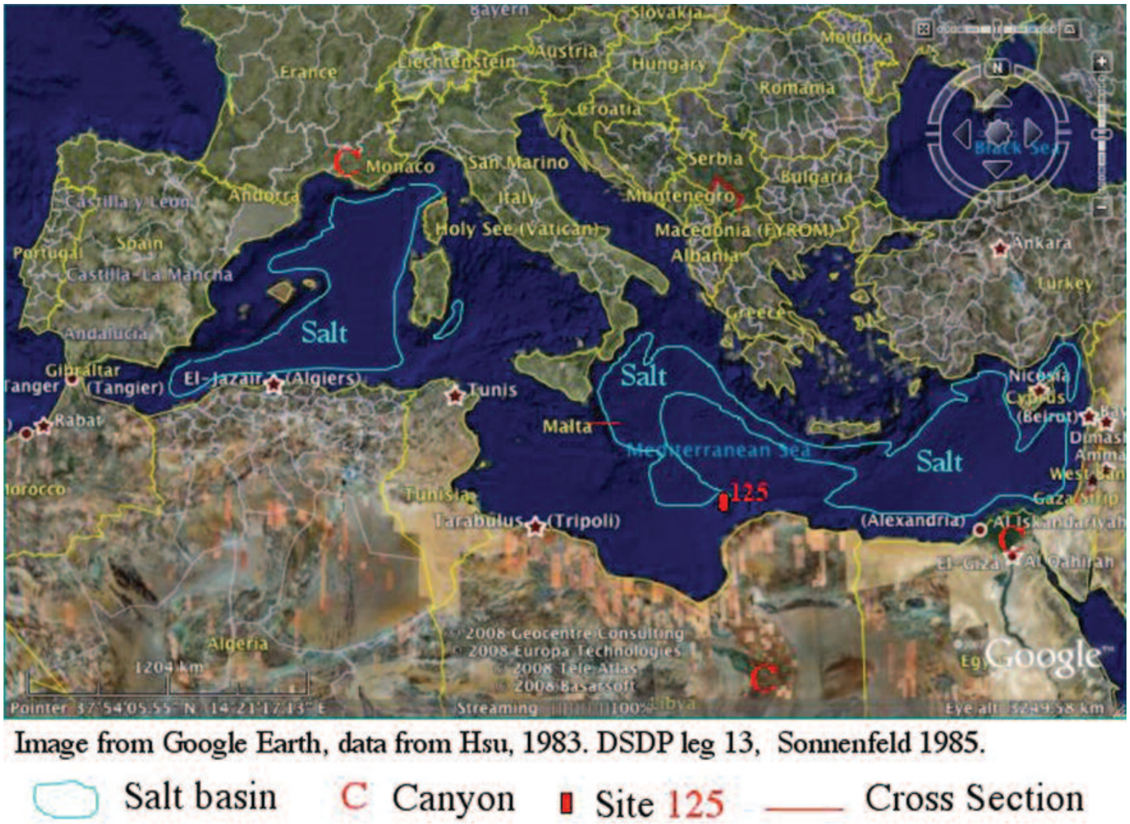

The Mediterranean Sea dried up and only salt lakes remain.

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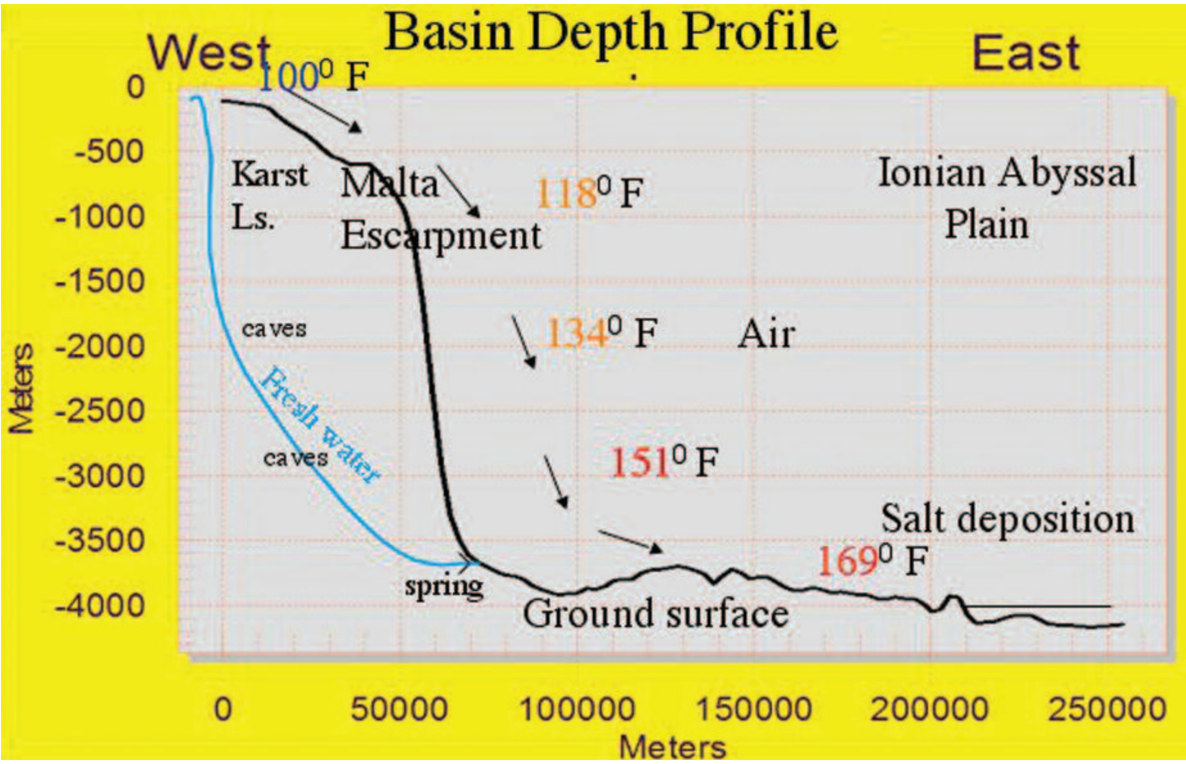

Air descending is compressed at a temperature lapse rate of 9.8° C per 1000 m (about 18° F per 1000 m).

down into a sub-aerial basin below sea level are heated by compression as they descend. This leads to extreme desiccation, the evaporation of brines, and even the deposition of potassium salts. The same winds can move sand dunes into the deepest portions of the basin. These potential reservoirs are not influenced by distance from shore, as are marine sands.

The most significant event in a sub-aerial sub-sea basin is the sudden flooding upon entry of the sea. Unlike a marine transgression that reworks sediments on gradually submerged land, the sea rises to fill the empty basin in a geological instant. There is little disturbance of the covered terrain. Sand dunes are drowned, preserving their shapes and cross bedding, as in the Permian Rotliegend of the southern North Sea. Porosity of sandstone may be preserved due to desert conditions leading to chlorite overgrowths on quartz, as is true of the Norphlet sandstones of the Gulf of Mexico.

Canyons cut to grade with the basin floor are distinctive of former sub-aerial sub-sea basins. They bring coarse clastics to the basin floor. Such buried canyons are found all around the Mediterranean and western Gulf of Mexico.

After the flood, mainly fine clay, carbonates, and organic matter settle out of the anoxic water. Rising H_2S from rotting vegetation of the suddenly drowned landscape precipitates metals from the ocean water and may cause metal-rich fine sediments such as the Kupferschiefer that overlies the sand dunes of the Rotliegend. The fines drape over the pre-existing dunes like a blanket of snow, following the curves of the former landscape.

A basin containing a drowned desert environment may have reservoirs that would not be expected if a uniformly marine basin model was used in interpretation and exploration. Realization that one may be dealing with desert sedimentation can result in interpretations that extend successful oil and gas plays and predict locations of new ones. ■

Biographical Sketch

Martin Cassidy worked for Amoco for 32 years around the world in assignments in production geology, new ventures, and operations. After his retirement from Amoco, he earned a PhD in geology from the University of Houston. (His undergraduate degree in geology was from Harvard University; he also has an MS in geology from the University of Oklahoma.)

Since receiving his PhD, Mr. Cassidy has continued as a research scientist at the University of Houston and also continues writing and consulting about petroleum exploration, basin analysis, and subsurface gases (both hydrocarbon and non-hydrocarbon). He gives special emphasis to CO_2, particularly its relevance to exploration for oil and gas.