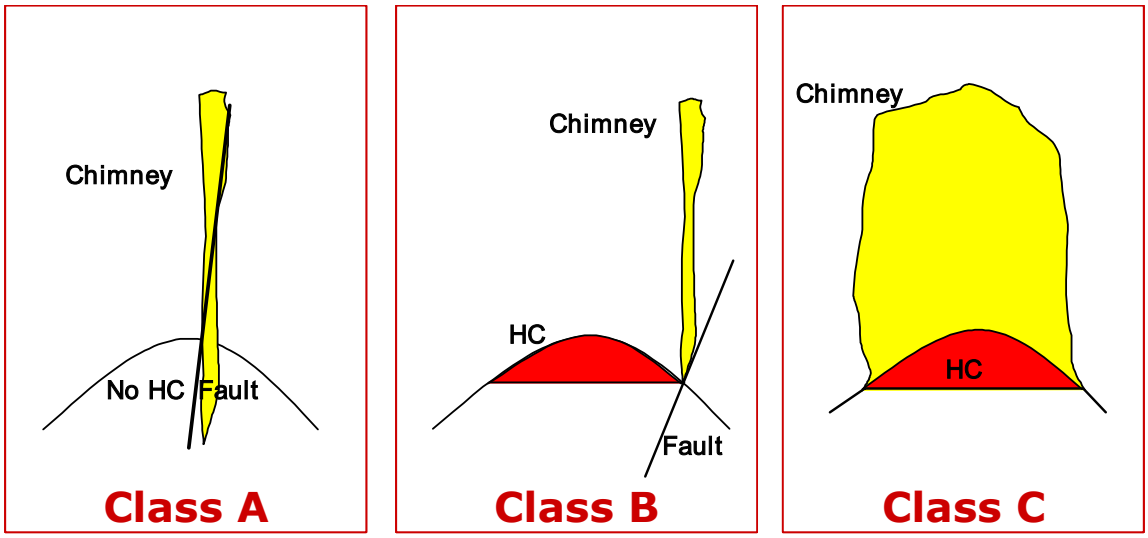
dGB Earth Sciences, Boulevard 1945 nr. 24, 7511 AE Enschede, The Netherlands, Ph: +31-53-4315155, info@dgb-group.com
dGB-USA, 1 Sugar Creek Center Blvd, Suite 935, Sugar Land, TX 77478, USA, +1 281-240-3939 www.dgb-group.com

Technical Update: TU-05-02
Date: March 7, 2005

Subject: Prospect Risk Assessment Using Chimney Technology

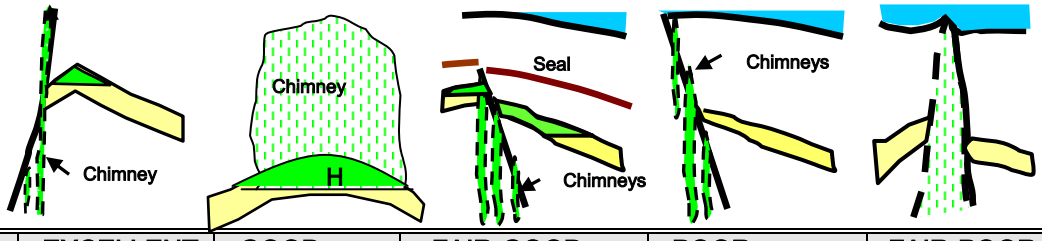
Chimney technology has been used for many applications such as gaining a better understanding of the petroleum system, identifying source rock expulsion, distinguishing between leaking and sealing faults and geohazard detection. Our ability to interpret different types of chimney responses in different settings has also improved as we have compiled catalogues of chimney volumes. As described in Heggland (2004) one can establish a prospect risking procedure using chimney technology. The presence or absence of chimneys, their shape and their origination point and their extent can be correlated with the integrity of the trap.

In the figure below, adopted from Heggland (2004), we divide different chimney types into three major classes, A, B and C. A breached reservoir with a chimney associated with a fault going through the crest of the structure is Class A. A chimney associated with a fault at the edge of the structure is Class B. More diffuse chimneys or gas clouds emanating from the top of the structure are referred to as Class C. Heggland shows very convincing statistics of different chimney classes versus presence or absence of hydrocarbons.



It must be emphasized that in practice, gas chimneys exist in a continuum ranging, from gas clouds to mud volcanoes. Roberts (2002) has studied modern seeps in the Gulf of Mexico slope. There, it is shown how seeps could be divided into mineral-prone seepage and mud-prone seepage. The former, involves low flux rates where biologic activity can keep up with hydrocarbon seeps. The latter involves high flux rates where seepage overwhelms the biologic community. The Table below captures the key aspects of chimney morphology, their related seeps, and their relationship to trap type and seal integrity.

Table: Chimney Morphology vs. Trap type/Integrity



SEAL/TRAP INTEGRITY	EXCELLENT	GOOD	FAIR-GOOD	POOR	FAIR-POOR
Chimney characte	No chimney over structure	Gas cloud	Fault related Internal seal	Fault related venting to surface	Mud volcano
Mechanism	Lateral charge	Diffusion	Fracturing	Fracturing	Sediment flow
Associated Seeps	Seeps off-structure	Mineral - prone	Mineral-prone	Mineral-prone	Mud-prone
Class	Class B	Class C	Class A1	Class A2	

In almost all of our recent case history examples, Heggland's classifications have been confirmed. 11 studies of commercial fields (by both Statoil and dGB) are indicated as Class B, 22 fields are Class C, 6 fields are Class A1, and 7 known breached accumulations are Class A2. As more analogues become available we may update and expand the classifications.

Distinguishing different chimney morphologies on seismic data is critical to assessing prospect risk pre-drill and assigning P10-P90 hydrocarbon column heights for volumetric calculations. It is especially critical to distinguish Class C from Class A chimneys, since the more diffuse chimneys may also have associated faults. Individual seismic volumes and single attribute displays are not adequate to distinguish chimney morphology. Normal P-wave seismic volumes can image gas clouds and mud volcanoes, but often cannot distinguish the two. Also more subtle fault related chimneys can be overlooked. Single attribute volumes, such as coherency or similarity, do not distinguish chimneys from processing artefacts (noise, different vintage data, different processing sequence for different segments of the data volume, etc.) and various geologic phenomena that create discontinuities, such as salt or faulting.

Suggested reading:

1- Heggland, R., 2004, Hydrocarbon Migration and Accumulation Above Salt Domes-Risking of Prospects by the Use of Gas Chimneys, Proceedings of 24th Annual GCSSEPM Foundation Bob F. Perkins Research Conference, *"Salt-Sediment Interactions and Hydrocarbon Prospectivity: Concepts, Applications, and Case Studies for the 21st Century"*, December 5-8, 2004, Houston, Texas,

2- Aminzadeh, F. and Connolly D., 2004. Hydrocarbon Phase Detection and Other Applications of Chimney Technology. AAPG Int. Conference, Cancun, 2004

3- Roberts, H.H., 2001. Improved geo-hazards and benthic habitat evaluations: digital acoustic data with ground truth calibrations. OCS Study MMS 2001-050. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, La.

4- http://www.dgb-group.com/upload/files/publications/fluid migration

For additional details please contact fred.aminzadeh@dGB-Group.com from North to South America or Paul.deGroot@dGB-Group.com from elsewhere.