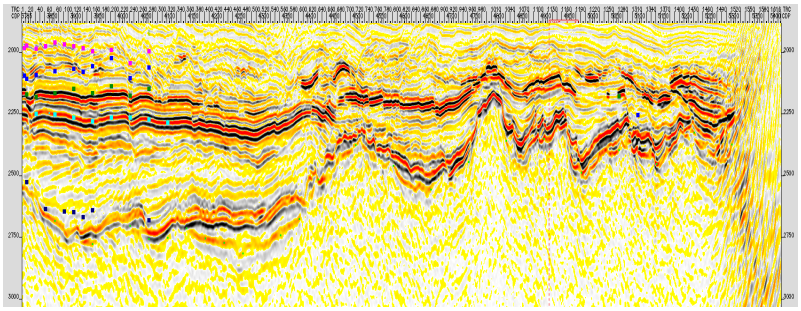
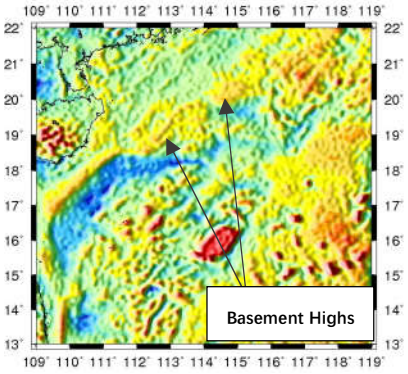
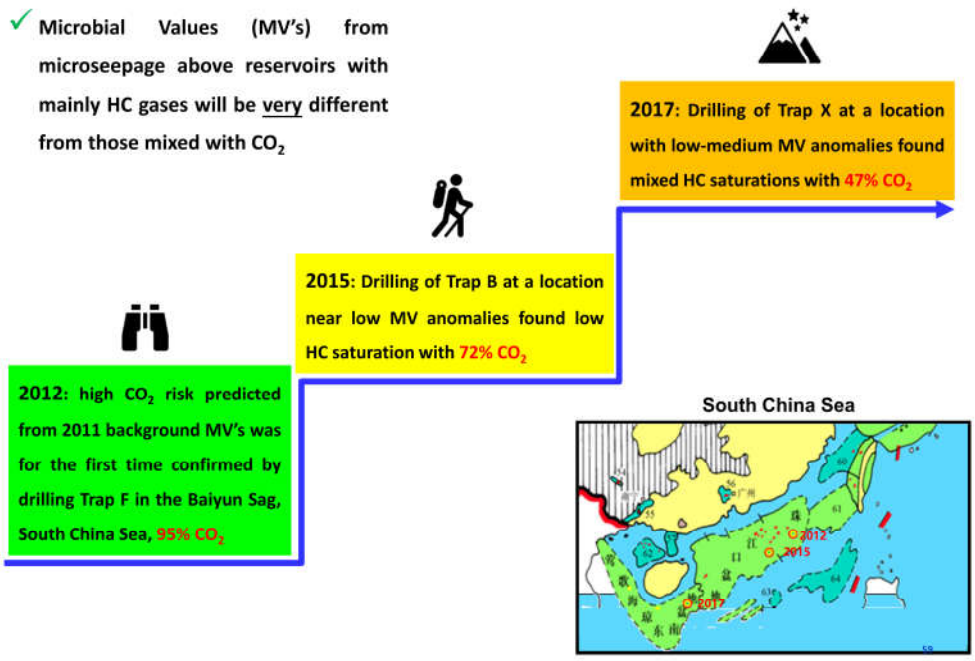
Mitigating CO2 Risk *using Microbial-Geochemical Exploration (MGCE)*

Background: Many CO_2-rich natural gas pools have been found in the continental margin basins of the northern South China Sea. In the Pearl River Mouth Basin, magmatic or mantle basement degassing of volatiles during the igneous intrusion stage are the most likely major source of CO_2. Upward migration pathways are facilitated by basement faulting. Since seismic detection techniques cannot distinguish CO_2 from hydrocarbon gases, a more reliable method is required to de-risk exploration efforts in similar exploration settings.





Regional development of basement highs and related faults



Case History, @WD 1500m: Located in the Eastern part of the Pearl River Mouth Basin. A 3D seismic survey identified a NS trending anticlinal trap with E-W faults. Primary targets are Oligocene delta-shore and deep-water fan sands in the Zhuhai Fm. AVO inversion and seismic softening indicated potential gas charge in the area of interest (warm colors). A well was proposed at a location with the most significant AVO effect. However, the results of a MGCE survey acquired pre-drill, indicated low background microbial values (blue, green) in the area where the NOC planned to drill. The anomalous areas of microbial activity (brown, red) suggested more attention should be given to the structure south of the drilling location. Evaluation of the MGCE results predicted a high risk of failure. The strong AVO anomaly proved however too compelling and the F-1 well was drilled in 2014 as planned, resulting in the discovery of a 25.3m "gas" sands with a composition of almost 95% CO_2.

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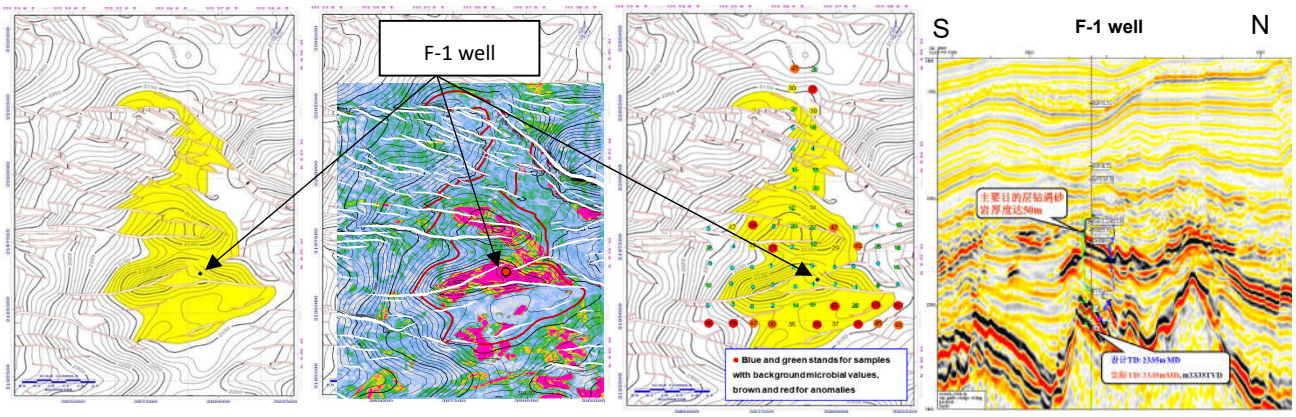
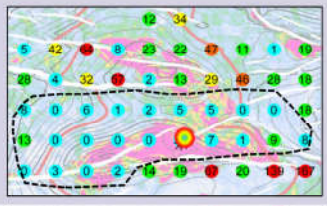
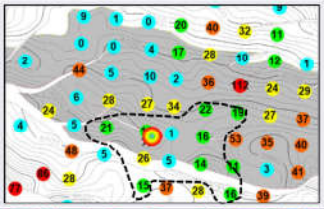
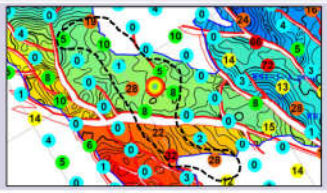


1.Depth structure with E-W faults 2. Attribute map 3. Microbial results 4. Seismic profile of the trap

Results from two case histories in the deepwater Baiyun Sag and Qiongdongnan Basin, South China Sea:

Well ID	Drilling Result	Microbial Anomalies	Anomaly Level
F-1	25.3m/5 gas layers, 95% of CO_2		Background
B-1	One gas layer of 4.9m, 72% CO_2		Low Anomaly
X-1	8m/4 gas layers, 47.3% CO_2		Low-Medium Anomaly

Conclusions:

1. Exploration targets in geological settings with a thin stratigraphic column overlying intrusive or crustal basement highs with related faults have a substantial risk of CO_2 charge. In other areas, chemical decomposition of deeply buried carbonates may also be a source of CO_2 and other non-HC gases.
2. 3D seismic attributes are unable to discriminate between HC gases and CO_2 and saturations. MGCE however, when used in combination with other information (i.e. seismic, gravity, magnetic surveys), can help to de-risk exploration targets and trends. Variation in MV's values is related to variation in CO2 composition and HC gas saturation.
3. MGCE surveys are particularly beneficial in areas where drilling is very expensive and minimizing risk is imperative. In many cases, proving hydrocarbon charge can improve the probability of success before drilling by a factor of two.

Recommendation:

With over 12 years industry experience of applying surface Geo-microbial and Geochemical exploration technologies integrated with Geology & Geophysics, AE&E is confident that it can successfully support frontier or reconnaissance exploration efforts in deep water continental margins, as well play to prospect maturation.

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