Amplified Geochemical Imaging's History of Innovation in the CCUS Industry

A primary mode of Carbon Capture Utilization and Sequestration (CCUS) is in which carbon dioxide (CO_2) is injected into underground geologic sinks. Critical to the success of geologic sequestration is ensuring that underground sinks have competent seal and will not leak, thereby posing a potential hazard to human health and the environment. However, the ability to determine if subsurface structures have adequate seal and will remain leak-proof is difficult, since there are few CO_2 monitoring technologies of appropriate sensitivity and coverage for underground sequestration – particularly offshore.

Amplified Geochemical Imaging LLC (AGI) plays a pivotal role in driving innovative soil gas vapor solutions for the CCUS industry, from very early in its inception.

Netherlands, 2002: An offshore passive soil gas survey was conducted to study natural analogues for future geological **sequestration of CO_2** in the Dutch sector of the North Sea - the first such survey in the region. The project, commissioned by TNO-NITG (Netherlands Organization for Applied Scientific Research – Netherlands Institute of Applied Geosciences), comprised 56 seabed cores taken from three specified areas. Cores targeted seabed and subsurface features, such as pockmarks, shallow gas-condensate reservoirs (not in production), gas chimneys and suspected leaking faults. The purpose of the survey was to **determine natural levels of hydrocarbon seepage** from these areas of interest.

Australia, 2012: AGI completed an onshore geochemical survey over several "priority areas" defined by the Victoria Department of Primary Industries (DPI), as part of their ongoing CarbonNet Project. The survey included over 140 samples placed over key areas of active petroleum systems in the Gippsland Basin, over known closures and regional top seals, and in the vicinity of major fault systems. The purpose of the survey was to provide hydrocarbon seepage data **to inform basin hydrocarbon migration models**, and to assess localized **seal integrity**.

Oman, 2012: AGI introduced ultrasensitive soil gas surveys to **assess seal integrity** for onshore carbon sequestration with a project in the Fahud Salt Basin in the Sultanate of Oman. The survey clearly differentiated baseline hydrocarbon signatures from elevated hydrocarbon expressions along specified fault segments, thereby indicating the gas reservoir may not be suitable for sequestration purposes.

Algeria, 2015: AGI is still involved in a multiphase **monitoring program for CO_2** in the Krechba Field of Algeria, involving three injection wells. After start of CO_2 injection, 3D seismic imaging revealed the activation of a deep fracture zone several hundred meters wide and extending ~150 m vertically (Rutqvist, 2012). Fluorinated tracers were incorporated in the injection stream to evaluate potential leakage points from the structure. AGI results indicated no detectable levels of fluorinated tracers or elevated levels of reservoir hydrocarbons at the surface. Thus, it appears that no breach to surface has occurred.

USA, 2020: AGI worked for eight years with PXGEO (formerly Seabed Geosolutions), to develop **mobile offshore CO_2 monitoring capabilities**. Most offshore CO_2 monitoring methods are performed at preexisting producing wells. Such methods are limited by the fact that producing wells are not always near CO_2 spill points. AGI and PXGEO innovated the attachment of passive geochemical modules to Ocean Bottom Seismic AUVs (Automated Underwater Vehicles). This enables mobile deployment of sensors for the collection of CO_2 seepage and high-resolution seismic data simultaneously, and directly over potential spill points.

USA, 2021: Sequestration structures, particularly saline aquifers, can be extremely heterogeneous. **Reservoir compartmentalization** can affect filling schemes as well as the cost associated with storage. Thus, it is important to identify internal reservoir complexity prior to CO_2 injection. AGI's Downhole Geochemical Logging (DGL) has been used to analyze cuttings samples from stratigraphic injection wells. DGL data can identify subtle differences in organic compound signatures from cuttings, signifying potential seals along the wellbore (vertical or horizontal).

USA, 2022: CO_2 signatures differ for each sequestration program due to impurities in the CO_2 point source (Pace, 2022), be it concrete facilities, LNG facilities, fertilizer plants, etc. While these impurities exist at very low *parts per million* levels, AGI's passive soil gas vapor methodology measures down to *parts per trillion* levels. As such, AGI's method can **monitor for CO_2** leakage by detecting impurities unique to injected CO_2, thus **eliminating the need for (and expense of) fluorinated tracers**.