Carbon sequestration beneath the New Jersey continental shelf: An assessment of the geological and socio-political factors

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Abstract

Carbon capture and sequestration (CCS) is a nascent technology that captures carbon dioxide from large point sources, such as power plants, and stores it in a geological formation a distance away. It thereby allows the use of fossil fuels as an electricity source while limiting their greenhouse gas emissions. The New Jersey continental shelf provides excellent potential for geological storage. We evaluated sequestration potential for the middle continental shelf with well log analysis of six dry industry wells on the Great Stone Dome (GSD). Sequestration potential is excellent in the Cretaceous (Cenomanian to Albian) Upper and Lower Logan Canyon Sand units; these porous sandstone beds in the subsurface, approximately 1800-2500 meters deep, are capped by shale that would potentially seal liquid CO_2. The GSD is potentially superior to outer continental shelf locations because hydrocarbons, particularly methane, have been vented and do not complicate sequestration in contrast to other areas studied.

A coal-burning CCS power plant (PurGen One) was proposed for Linden, New Jersey with planned storage on the outer continental shelf or continental slope in 2009 by SCS Energy, but was put into stasis in 2011. An assessment of the social and political factors indicates that PurGen One had an unsuccessful end due to opposition of political figures and environmental activists, financial difficulties, and regulatory uncertainty. The lack of support from the city of Linden and from the administration of Governor Chris Christie had convinced the company, SCS Energy, to abandon their plant and move their efforts to California-based coal CCS plant which will use carbon capture and sequestration for enhanced oil recovery.

Geological Setting

New Jersey's continental slope and shelf have thick Cretaceous sands with fine-grained confining beds, due to high global sea level in the Late Cretaceous through the Eocene.

There is little evidence in this area of major faulting, rotation, or other structural disturbances that could cause CO_2 leaks.

The Stone Dome, located offshore New Jersey (Fig. 1a), has potential to sequester liquefied carbon dioxide. It is an igneous intrusion that can be associated with an early Cretaceous mafic intrusion. It is closer to the coast than COST B-2 and B-3 wells and has potential of a stronger seal. It appears that natural gas found on the outer shelf limiting storage was vented by the intrusion.

The blue box containing COST B-2 and COST B-3 wells has detailed information on the CO_2 storage potential. The yellow box is an extrapolation of this information, with an estimated 200-700 Gt of CO_2.

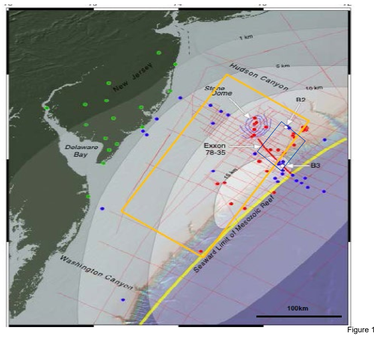

Figure 1a

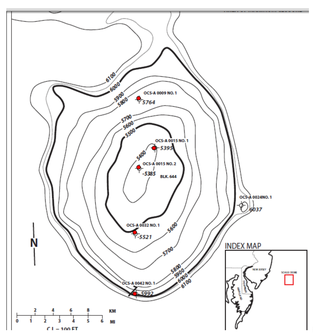

Figure 1b

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Well Log Analysis

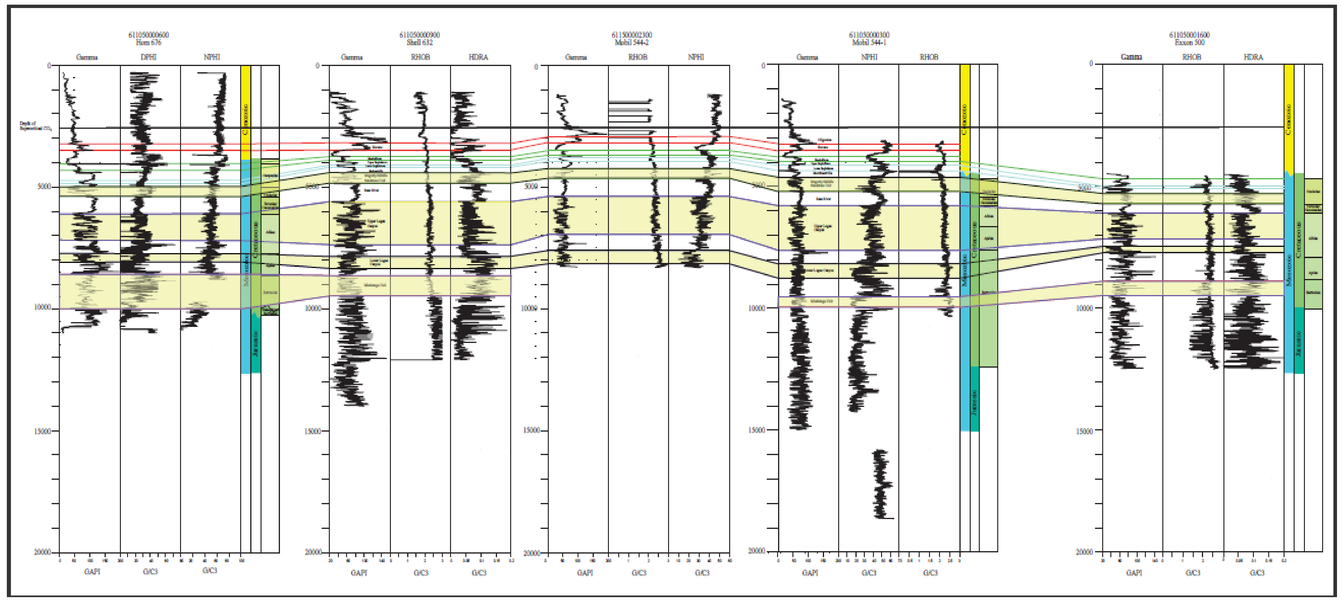

Figure 2a

Well log data (gamma ray, density, and neutron logs; Fig. 2) for five wells in the Stone Dome area (Hom 676. Shell 632, Mobil 544-2, Mobil 544-1, and Exxon 500) were analyzed for shal versus sand content. The logs were interpreted individually, then correlated across to find similar shales and key sand units that can sequester carbon dioxide (Fig. 2, yellow): The Middle Sandstone Unit, the Upper Logan Canyon, the Lower Logan Canyon, and the Mississauga Unit, which were previously named.

We estimated the amount of carbon dioxide that can be stored in each sandstone unit (Table 1, in gigatons CO_2). Three efficiency factors are taken for each sand, which is the percent of pore fluid that can be displaced by the injected CO_2. These estimates are low and the reservoirs have potential to store even more carbon dioxide once injection occurs.

Storage potential took into account the temperature and pressure of the reservoir, which computes the density of CO_2. Porosity of 20% stays constant and acreage of the sandstone unit is taken into account.

Carbon Sequestration Potential

Geological Formation	Gigatons of CO_2 Storage		
	1% Displacement	2.5% Displacement	4% Displacement
Middle Sandstone	0.23 Gt	0.57Gt	0.92Gt
Upper Logan Canyon	0.23Gt	0.59Gt	0.93Gt
Lower Logan Canyon	0.30Gt	0.76Gt	1.2Gt
Mississuaga	0.44Gt	1.0Gt	1.7Gt

Table 1

Political and Social Factors

A carbon capture and sequestration plant called PurGen One was proposed for Linden, New Jersey in 2009 by SCS Energy, a private power plant company. This plant was used as my case study, and stirred debate and controversy in Linden and throughout New Jersey. Local union workers wanted the deployment of PurGen for the jobs and economic growth of the city, while environmental activists, local and state-wide, advocated for cleaner energy technologies. The governor, Chris Christie, previously stated that no more coal plants will be deployed in New Jersey and although CCS stores the carbon dioxide underground, there was still opposition due to coal usage.

1. *Public Acceptance*- Government agencies and large non-profit organizations, such as the Department of Energy and Natural Resource Defense Council accept CCS as a clean energy technology and three plants throughout the world have been storing CO_2underground. More experiments are being funded and supported by many large stake-holders and government policy-makers.
2. *Community Acceptance*- The Linden community was split: Union workers supported increased revenue and job creation in the area, while environmentalists argued for cleaner technologies, spoke of environmental risks, and revealed health issues for local families. Two main problems throughout the community were the lack of knowledge about the plant and NIMBY (not in my backyard.)
3. *Market Acceptance*- One main policy maker, governor Chris Christie, stated there will be no more coal plants in New Jersey prior to the PurGen One proposal. He kept his word and fought the plant until August 2011 when it was stated by President of the Board of Utilities Lee Solomon that there will be no PurGen One.

Conclusion

Our well log analysis suggests storage potential of up to 2 Gt on the Stone Dome, which would allow seuqestration of 10 PurGen plants (5MtCO_2/year, which plans to store 200 Mt). PurGen One did not fail because of one factor; it was the combination of opposition from an important government figure, resistance from local and state-wide environmental advocates, financial difficulties, and regulatory uncertainty that deterred PurGen One from deployment. With CCS still widely experimental, safety and environmental issues were the main concern for citizens of Linden, New Jersey. Investment towards carbon capture and sequestration seems unlikely when there are other renewable energy systems that are proven to be safe and effective, and also have lower costs to develop than a CCS plant. With more research and development, carbon capture and sequestration has potential to be a clean energy technology that also uses fossil fuels.

In this study, well logs were provide by Slater and analyzed by Hlavaty, Miller, and Browning. Storage estimates were made by Hlavaty and Reinfelder. Thanks to Rachael Shwom for advice on social-political frameworks. Thanks to Zuhal Seker, as her thesis aided me in correlations and understanding of well log data.