

## **SALTWORK'S RESPONSE TO PROF. CATHLES' COMMENTS ON "Should Salt Mining Under Lake Cayuga Continue."**

By Angus Ferguson and John K. Warren. 23 August 2017.

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Prof. Cathles comments do not address the points on geological instability and risk of mining collapse by continued northward extension of the mine below the thinned carbonate beam area, as outlined in the Ferguson and Warren (2017) seismic-focused report.

In the oil industry, the evaluation of geological risk has long been a topic of research as all wells drilled need to have a geological risk assessment to determine the economic value of the well.

This technique can also be applied to the geological risk assessment of mining for salt under the Cayuga Lake. The risk assessment is focused on the possible outcome of a mining collapse similar to the Retsof Mine. This approach also centers the discussion into separate 1) model-based general comments, and 2) data-based observations and interpretations.

In the risk assessment, the model-based information is the analogue model of the Retsof Mine collapse and the problems with roof stability in the now abandoned Himrod Mine on the shores of Lake Seneca. Both are in a near-identical geological situation as the area of the Cayuga Mine as it extends north of its current position (analogues are detailed in the Three Mine Comparison report, Warren, 2016). In terms of risk, the analogue model would be rated as most likely the same.

The next step is to evaluate the actual direct data used to evaluate the geological risk. This was explained and quantified in the Ferguson and Warren 2017 report where three separate methods show that the carbonate beam supporting the overlying rocks in the area north of the present mine under the Cayuga Lake has been eroded out or greatly thinned. This has resulted in a geological condition with more risk than the Retsof mine was in, before it collapsed. At present, the direct data analysis would rate the geological risk of collapse as likely. Combining the analogue model with the direct data assessment, then the chance of a mine failure by salt extraction under the Cayuga Lake as the mine moves north using present mining methods, would be greater than 50%.

The key to better quantification of this assessment is improved quality and quantity of direct seismic and geological data. If there are seismic data available of sufficient quality that prove the carbonate beam under the Cayuga Lake is not as thin as the present limited seismic data show or that there is no evidence of major fractures within the layers separating the proposed mining cavity from the overlying glacial sediment aquifers, then the geological risk would be lowered. If the data prove that the thinning is present and there are significant fractures in the overlying rocks, then the geological risk of a mining collapse would be increased.

The current quandary can be solved very simply by allowing an analysis of all of the seismic and geological data that has been acquired in the area before any significant mining and shaft construction goes ahead. The seismic data that were specifically acquired to image the present mining area and the future mining area are crucial in this assessment. The Ferguson and Warren (2017) report has already demonstrated that the mining cavity can be imaged on the seismic data. Likewise, full access to the geological data and core acquired in the drilling of Corehole 18 would improve the veracity of the future seismic interpretation and assessment of mine roof condition.

It is expected that there are seismic data available that can further define the carbonate beam thickness and evaluate if there are any major fractures in the overlying rocks of the proposed mining areas. Access to this data base would greatly focus the present discussions that are using a limited data set. Without access to, 1) existing seismic collected over Cayuga Lake and surrounds and 2) to geological data (including core) from Corehole 18, a generalized debate between two opposing points of view will continue without scientific resolution.

## **References**

- Ferguson, A., and J. Warren, 2017, Salt Mining and Possible Future Problems in the Cayuga Lake Region: Integration of public-domain seismic with known salt geology, Saltwork Consultants Report, p. 24.
- Warren, J. K., 2016, Implications of a comparison of geological and hydrological conditions in the Akzo-Retsof, Morton-Himrod and Cargill Cayuga salt mines, New York State, Saltwork Consultants Report, 23 p.