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Technical Conference Paper

1965 – 2025

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SMRI Spring 2025 Technical Conference
27-29 April 2025
Wilhelmshaven, Germany

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The Bekendam-Jakob-Pinkse (BJP) subsidence prognosis algorithm for migrating salt caverns in a bedded salt deposit near Hengelo, The Netherlands

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Abstract

The historic development of the Nobian cavern field in the Twenthe-Rijn (TWR) mining permit (incl. extensions) has been divided into five phases based on the cavern development strategy and technological developments since the nineteen thirties. (The late) Roland Bekendam prepared a cavern migration model for caverns developed during “Phase 1” and “Phase 2” as presented during the 1997 SMRI Spring meeting in Krakow (Bekendam, 1997). Development of caverns in this area commenced from the 1930’s up to the 1970’s. During this period, measures to control the leaching process such as the use of a blanket medium and regular sonar surveys were not available or in the early stages of development and application. Roof stability of a number of caverns was severely compromised and led to upward migration of caverns. The Bekendam method enabled preparation of subsidence prognoses over migrating caverns and allowed Nobian to devise a backfilling strategy using brine purification residues as a resource. The prepared prognoses allowed for a prioritisation of backfilling efforts for caverns which could potentially lead to sinkholes. Since 1975 Nobian has developed caverns for which roof instability is no longer a concern. Hence, this study is on early developed caverns.

New data, information and insights were gained since the initial development of the Bekendam method in the 1990’s which permitted an elaborate update of the method. The update was aimed at addressing several processes relevant to cavern migration which were not included historically. The new Bekendam-Jakob-Pinkse (BJP) algorithm is thus an analytical/empirical extension of the historically used Bekendam method. The BJP Algorithm has been validated using 10 well-documented cavern migration cases from the Hengelo cavern field. After its validation, the BJP Algorithm has been applied to a set of early developed caverns in the TWR area to establish the likelihood of potential migration and to determine the total subsidence if migration occurs.

In conclusion, the study showed that a large number of caverns can now be classified as stable and/or intrinsically safe. This means that these caverns cannot cause a significant effect at surface. This facilitates a significant reduction of the overall time and material volume needed to backfill relevant caverns in the Hengelo area. Completion of the required backfilling based on the outcome of the BJP Algorithm is deemed attainable within a “single generation” rather than taking well over a century, thereby reducing Nobian’s risk exposure.

Key words: salt caverns, cavern abandonment, rock mechanics, subsidence