

## **Abandonment of an extremely deep Cavern at Frisia Salt**

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### **Abstract**

Since 1995 rock salt has been solution mined at the Barradeel concession near Harlingen in the Northwest of the Netherlands by FRISIA Zout at a depth between 2500 and 3000 meters making it the deepest salt mine in the world (Gillhaus 2006). This extreme depth has some implications for the mining process. At this depth the higher differential between rock and cavern pressure and the higher geostatic temperature than for conventional caverns accelerate the salt creep.

In 2004 the subsidence limit was almost reached at the BAS-1 and BAS-2 caverns. At this time the abandonment project of BAS-2 started. The BAS-2 cavern was shut-in for a long term high pressure shut in test and four bleed off and compression tests were performed. After the shut-in these pressures were recorded and are now simulated by a model incorporating creep, cavern heating and permeation.

Compression tests and the comprehensive model indicate that the cavern has been in a continuing permeating condition soon after shut-in and that the rate of fluid leak off stays below fracturing levels.

The BAS-2 cavern shows normal heat-up behaviour for a shut in cavern. The major expansion effects of heating up of the cavern contents and cavern surroundings have been incurred as a permeation process without any indication of formation fracturing.

As the differential between the virgin far field and cavern pressure, hence the squeeze rate, reduces in the future and the major effect of temperature expansion has been incurred it is considered very unlikely that fracturing conditions will occur in the future. Hence fluid will be displaced from the cavern in a permeation process.

The drive mechanism for permeation will weaken with time - as the cavern shrinks –and likely result in a ‘spongy’ salt/rock mass above and around the top of the cavern. Once the fluid pores and fluid filled spaces have no further communication with the cavern drive mechanism the migration process is expected to stop. The effects on subsidence of the expected migration process is thought to be marginal. The compression tests and the comprehensive model suggest the presence of high linear creep.

**Key words:** Cavern Abandonment, Hydraulic Fracturing, The Netherlands, Zechstein