CASE STUDY

Heavy Oil Well Surface Casing Vent Flow & Gas Migration

Introduction

In September 2021, a horizontal well was drilled in the heavy oil field of Bellis in eastern Alberta utilizing specific casing and cement blends to address potential gas migration issues. The well, turned into production in October 2021, exhibited surface casing vent flow/sustained casing pressure and in-soil gas migration, prompting intervention by 360 Engineering & Environmental Consulting (360). The wellbore integrity issues were diagnosed, and remedial operations included pulling out sucker rods and production tubing, setting a retrievable plug, and deploying various logging tools. Analysis revealed annular gas from the Colorado formation leading to a targeted intervention at a shale seam at 280.0 mKB. Despite initial challenges in initiating injectivity into the remedial perforations, a series of interventions including acidization and cementing were successfully executed. The pressure test initially failed but was resolved through a second cement job resulting in the elimination of surface casing vent flow and in-soil gas migration.

Well History

The well, drilled horizontally in the Bellis field of eastern Alberta in September 2021, featured surface casing set at 244 m and production casing at 819 m with specific cement blends to prevent gas migration. Upon production initiation in October 2021, issues of active surface casing vent flow and sustained pressure led to gas migration testing, revealing in-soil gas. The operator reported integrity concerns to the Alberta Energy Regulator (AER), triggering a mandated 90-day repair period.

Wellbore Integrity Assessment and Initial Measures

360 was engaged to address wellbore integrity issues. Sucker rods and production tubing were removed and a retrievable plug was set at 593.9 mKB to allow for the wellbore to stabilize. Logging tools, including a fibre-optic cable deployed for noise/temperature, radial cement bond, and cased hole analysis, identified potential annular gas sources from below plug back depth and the Colorado formation. In-soil and surface casing gas analysis confirmed thermogenic gases from the Colorado formation.

Targeted Intervention at Shale Seam (280.0 mKB)

Due to challenges correlating lower wellbore gas to surface flow, a shale seam at 280.0 mKB was chosen for intervention to re-establish cap-rock integrity. Perforations were made in two runs using alternatively phased 2.0 m x 101.6 mm ERHSC 17 SPM 50-degree perforation guns. Acidization with a synthetic organic acid blend and subsequent injectivity test attempts were made to improve connectivity to the annular space. Despite initial challenges, a successful bradenhead cement job with a 1901 kg/m^3 class “G” blend was performed.

Intervention Process and Immediate Results

Following curing, the first cement plug was pressure tested revealing failure, but a reduction in shut-in surface casing vent pressure. A second cement job using a 1650 kg/m^3 micro fine blend was performed, followed by a bradenhead squeeze. After curing, the cement plug was drilled out and the wellbore passed a subsequent pressure test. The shut-in surface casing vent pressure decreased further, eliminating vent flow.

Results

The culmination of the intervention efforts led to the successful resolution of the wellbore integrity issues. The pressure test, after the second cement job, confirmed the well's stability, with the shut-in surface casing vent pressure significantly reduced. Vent flow was entirely eliminated, demonstrating the effectiveness of the comprehensive intervention strategy.

Figure 1: Carbon Isotope Analysis

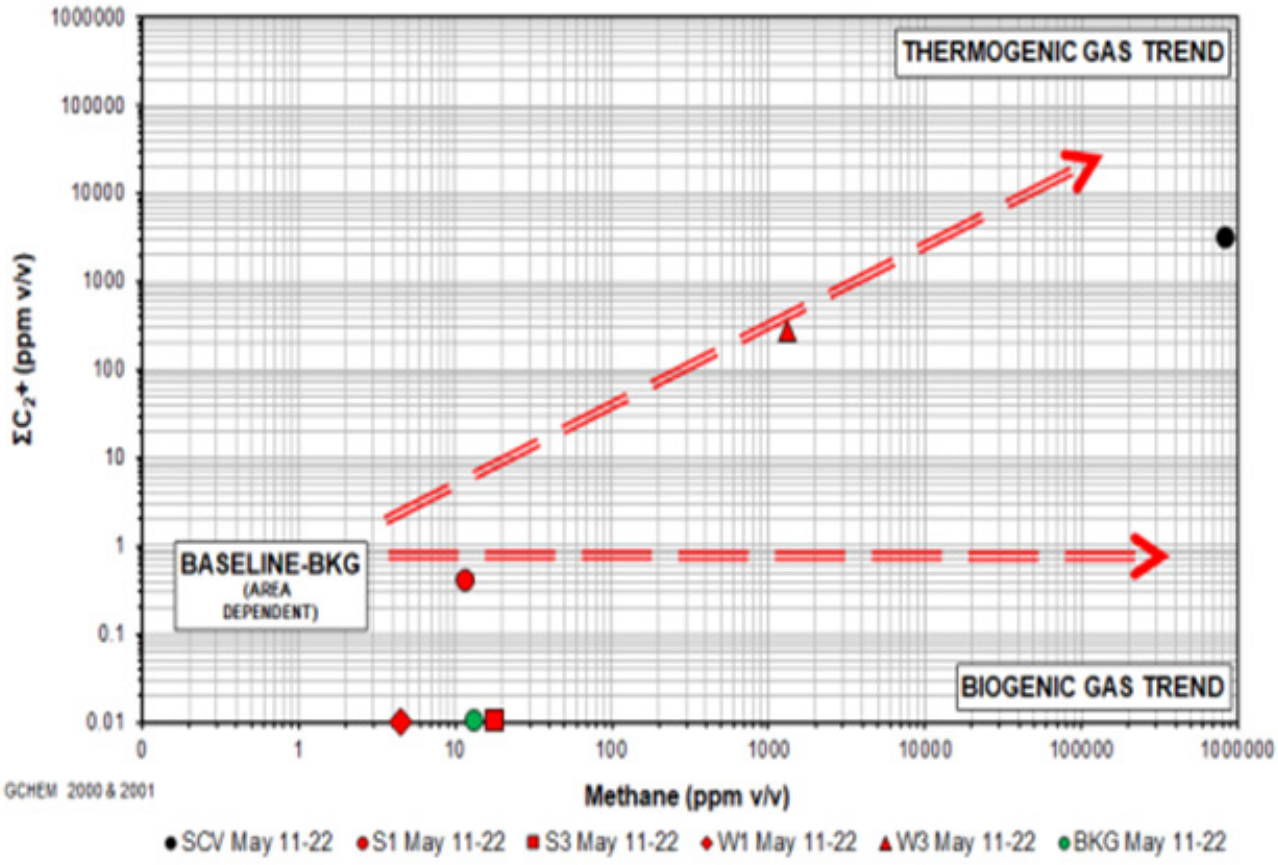

Figure 2: Frequency Spectrum Plot

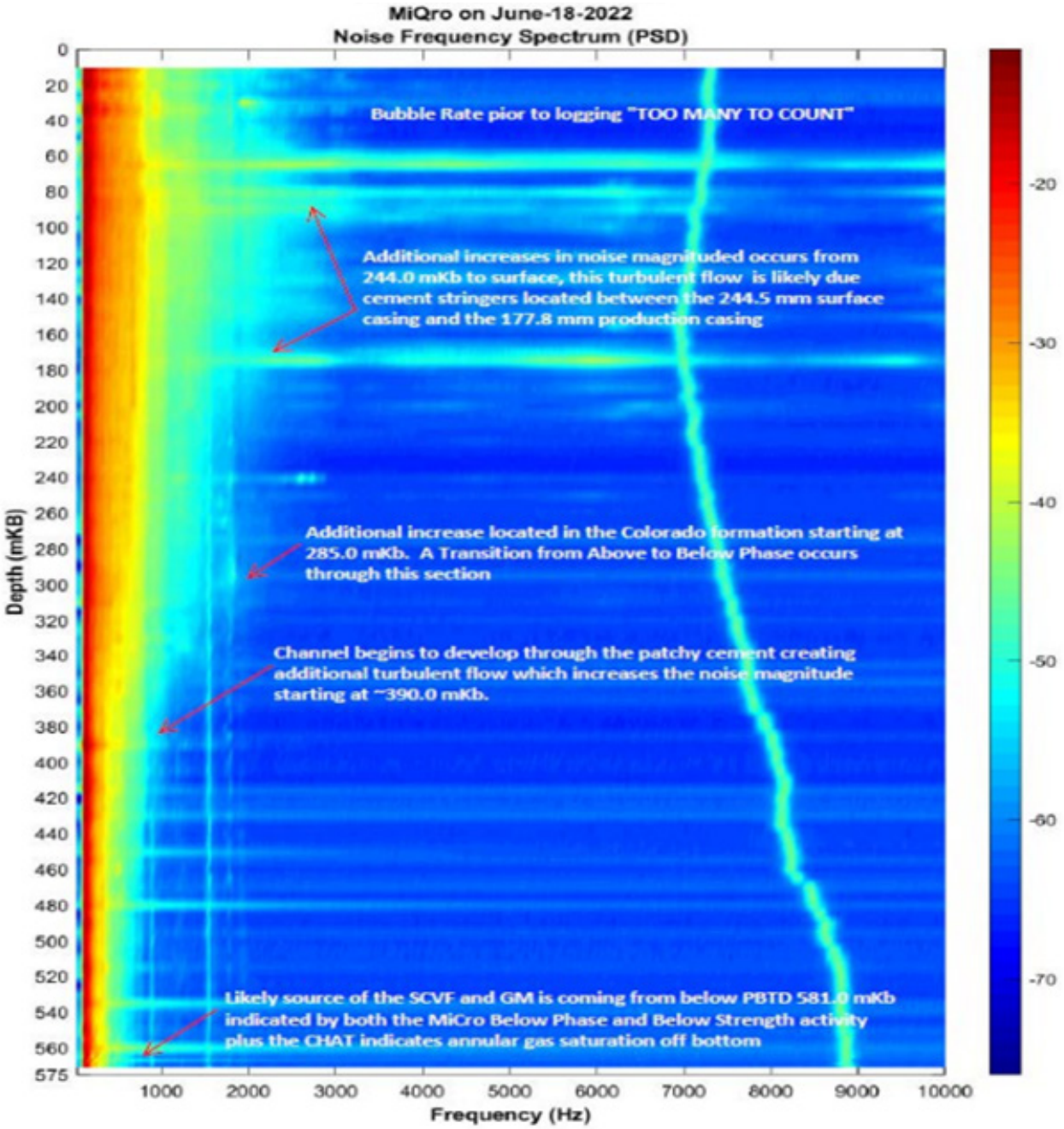

Figure 3: AOI - Off Bottom

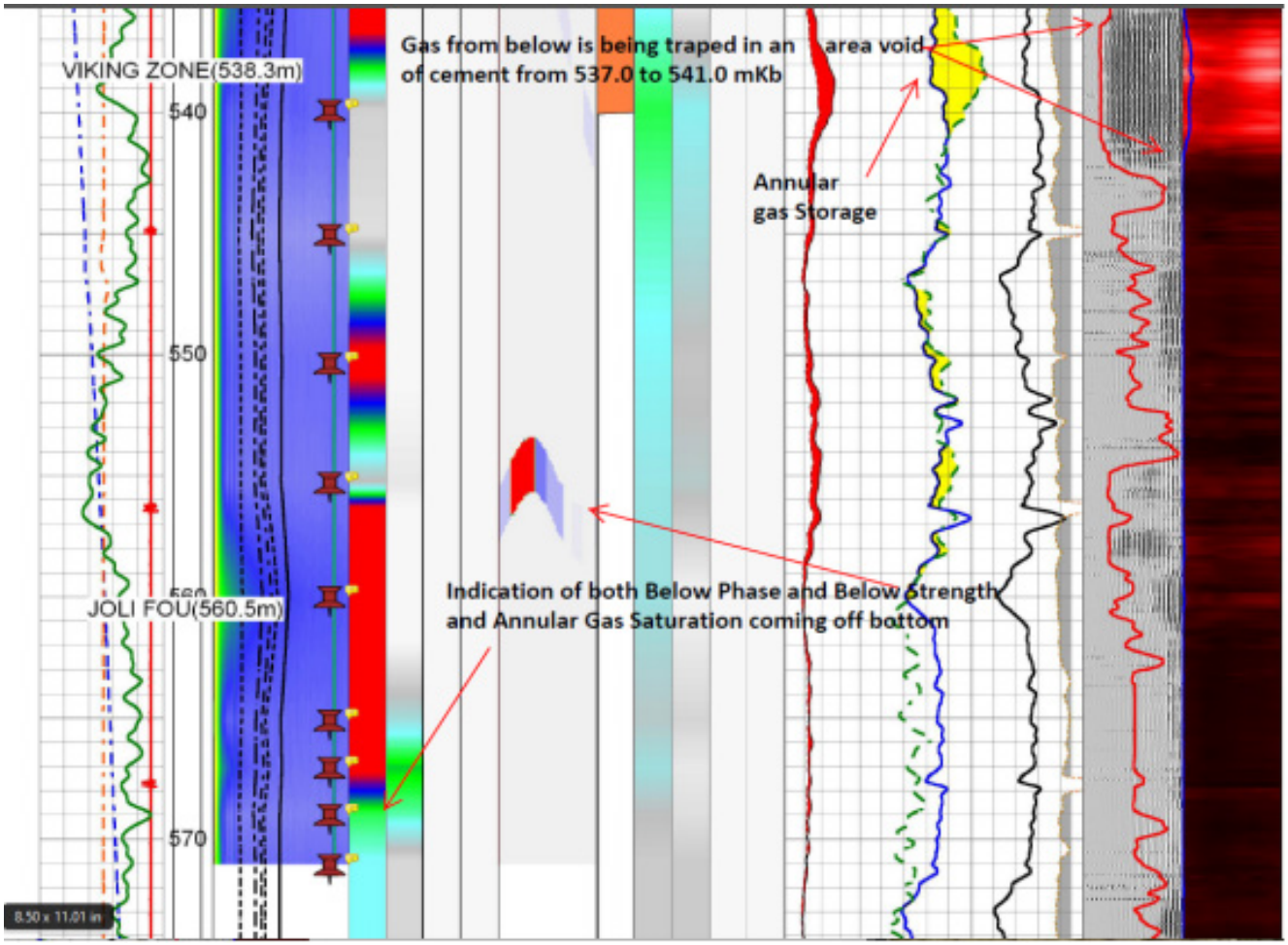

Figure 4: AOI - Colorado Formation

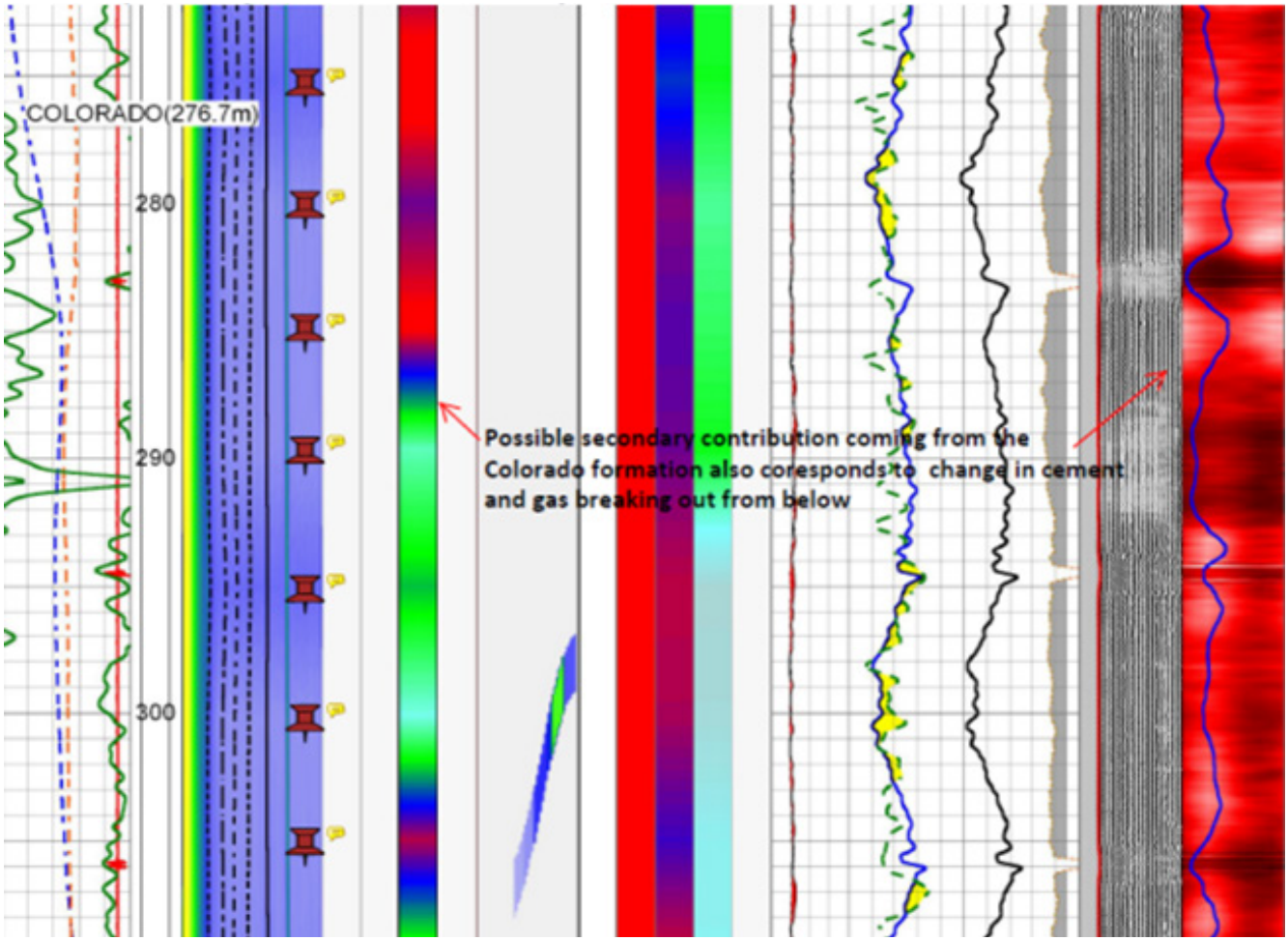

Figure 5: Cement Chart