Proactive Utilization of Geomechanics for Heavy Oil Production

BitCan Geosciences & Engineering Inc. Suite 109, 2770, 3rd Ave, NE, Calgary, Canada, T2A 2L5
www.bitcange.com; info@bitcange.com; (403) 235-5520 (phone)

Development of heavy oil reservoirs requires stimulation to reduce the oil viscosity. It is often achieved through steam, solvent or other chemical injection, giving rise to the broad term of "stimulants" for these activators. Many diverse technologies exist and their efficiency all depends on the reservoir-stimulant contact. The greater the contact area, the more efficient the stimulation. Geomechanical dilation and micro-cracking is the most effective mechanism to increase porosity and create new pore space. This results in an increased reservoir-stimulant contact. Figure 1 illustrates this effect.

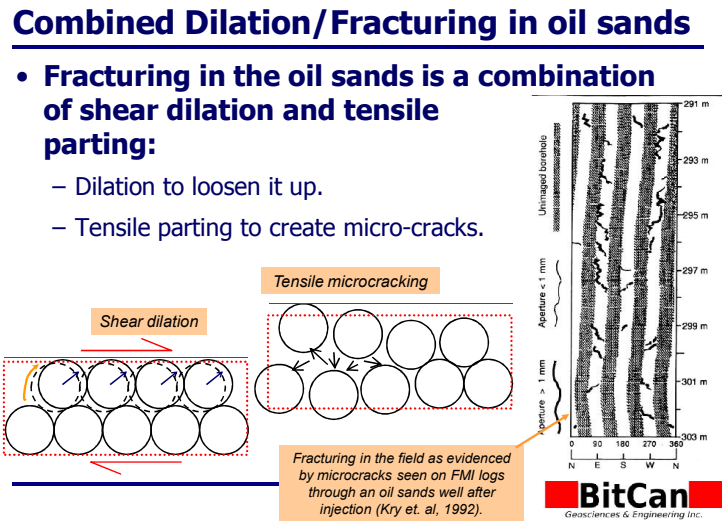

Figure 1: Dilation and micro-cracking seen on image logs in an unconsolidated heavy oil reservoir after a high-pressure injection test.

The other equally important issue in heavy oil production is reservoir containment integrity. Simulation of the heavy oil reservoirs significantly disturbs the casing and caprock integrity. There have been many field case histories where integrity was breached, including casing leaks, difficulties in well re-entry, reservoir fluid escaping to shallow horizons or even to the ground surface, steam leaks or blowout, well blowout during infill drilling, etc. Some examples are illustrated in Figure 2 below. These incidents cause cost overrun, loss of production, loss of reserves and even loss of operation licenses. It also causes environmental damage and loss of economic values from the natural resources to the society.

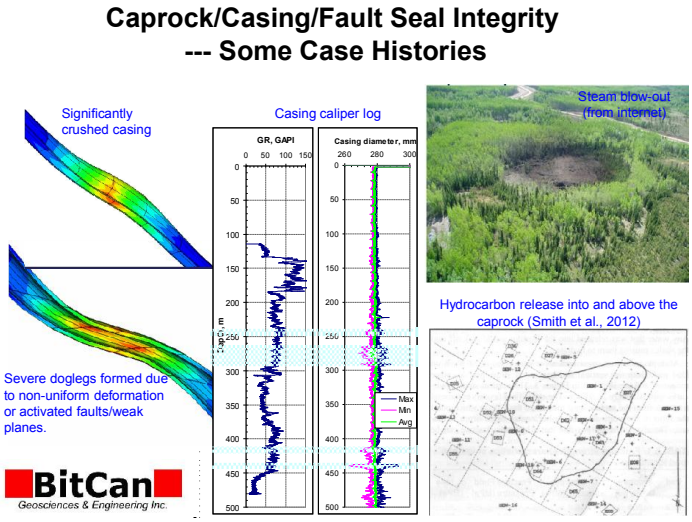

Figure 2: Some example case histories of casing/caprock integrity breaching.

Since 2000, BitCan has developed innovative reservoir recovery technologies and provided niche technical services proactively utilizing geomechanics for heavy oil producers. As an integrated technical consulting, service and R&D firm, BitCan's capabilities, expertise and experience has greatly enhanced heavy oil development at every stage of the development: formation characterization, reservoir development design, field execution and production optimization. We have successfully used geomechanics to increase the heavy oil production rate, reduce the stimulant-oil ratio, extend the reservoir recovery factor and mitigate impact on the casing/caprock. Below, some relevant examples will be shared.

1. FUSE^{TM} (patent pending) - Fast and Uniform SAGD Start-up Enhancement

FUSE^{TM} uses a short period of high-pressure injection to create a high-porosity/mobility dilation zone that vertically connects the SAGD well pair. Through our onsite analysis and interpretation we are able to ensure this dilation zone propagates uniformly along the length of the well pair and is confined to the space between the wells (Figure 3). It was developed by BitCan jointly with Cenovus Inc. and proven in 2010 in its Christina Lake SAGD project on 2 SAGD well pairs. Since then, it has been applied successfully in estuarine or braided fluvial deposits. All have achieved much earlier production start, improved production rates and a rapidly dropped CSOR (Figure 4). FUSE^{TM} is also proven able to break down shale stringers near the wells, thus increasing reservoir recovery.

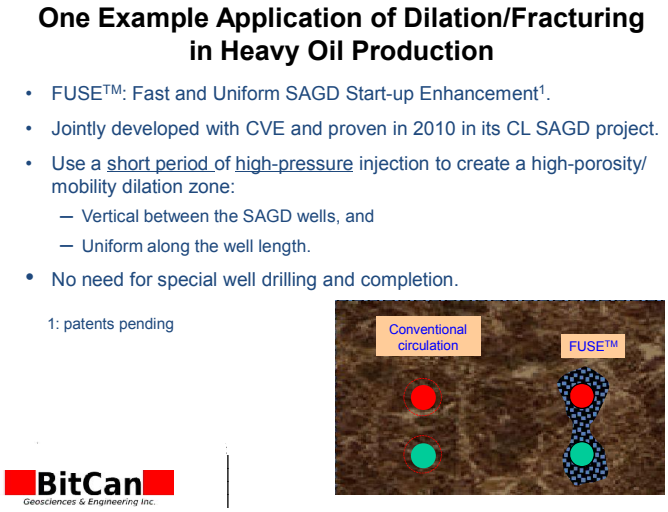

Figure 3: A schematic about BitCan's FUSE™ technology.

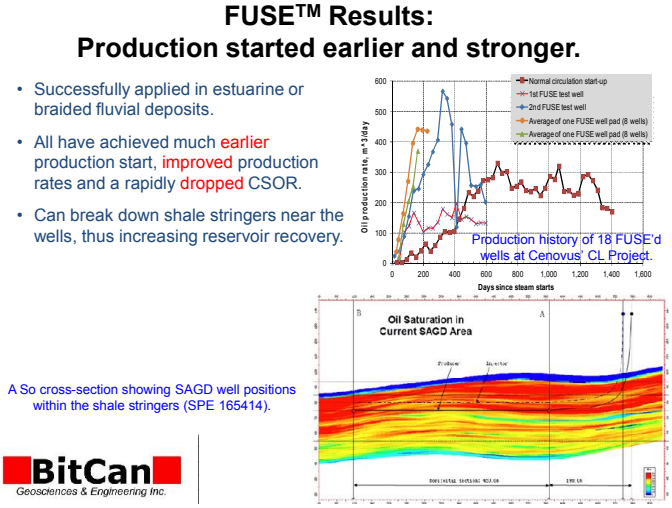

Figure 4: Field data showing FUSE™ able to significantly accelerate SAGD start-up, increase early production rates, decrease CSOR and break down inter-well shale stringers.

2. Implications of FUSE™ for non-SAGD heavy oil recovery processes

Application of FUSE™ in its current form in non-SAGD recovery processes waits for being field-tried. However, its success has fundamentally demonstrated the potential of using geomechanical dilation mechanisms to help place stimulants at target times, locations and in controlled directions. This knowledge is valuable for all heavy oil recovery processes. For example, FUSE™ uses water injection to create the reservoir contact before the steam injection. As a result, a channel is formed which allows for the preferential concentration of the subsequently injected steam. In fact, FUSE™ employees what is already sought after by the current hydraulic fracturing sector, i.e., volumetric fracturing. In the heavy oil production, volumetric fracturing creates the domain in which the injected stimulants flow and at the same

time it increases stimulant's contact area with the heavy oil. As a result, the well injectivity increases and the stimulation effect is improved. Some non-SAGD well conditioning innovations have already been developed by BitCan and await deployment in a pilot project.

3. Total solution to containment (casing/caprock) integrity

BitCan has proven technologies and/or services to accurately characterize the reservoir and caprock for geomechanical properties and in-situ stress condition, to simulate the complex nonlinear coupled Thermo-Hydro-Mechanical (THM) processes in the caprock, to design an optimized maximum operating pressure (MOP) and to provide continuous diagnosis and prognosis on the caprock integrity via monitoring and inversion of the monitoring data. All these services have been proven in hundreds of projects in serving almost all heavy oil producers in Canada and most in the world. Our deliverables (data, designs and solutions) have been regularly accepted by the government regulators and greatly valued by the industry[1]. Figure 5 illustrates our total solution framework.

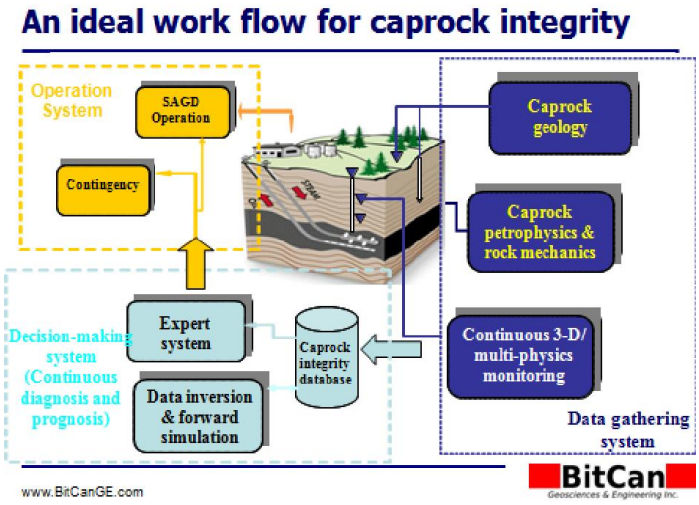

Figure 5: BitCan's total solution program to containment integrity. It gathers field data, including accurate pre-project characterization and in-project monitoring, carries out continuous diagnosis and prognosis on the caprock performance, including pre-project MOP design, and always works together with clients for the field operation.

4. Integrated service capabilities at BitCan

BitCan was founded in 2000 with a mission to proactively utilize geomechanics for the unconventional oil/gas development. Integrity, innovation and integration have been our core

[1] Our capabilities and experience is equally applicable to and proven in other subsurface processes, such as underground gas or waste or CO2 storage and massive hydraulic fracturing. More and more induced seismicity has been reported recently. It is one form of overburden integrity issues.

guiding principles. Our clientile includes almost all oil/gas operators in Canada and many in the world. We have a highly-educated work-force that devotes almost 50% of its time to ongoing R&D activities. BitCan owes much of its success to our command of basic theories and integrated capabilities covering field, lab and simulation needs[2]. Our truly integrated nature is best reflected in the fact that our capabilities are located under one roof and many scientists or engineers at BitCan go to the field to execute the tests and come back in-house to set up the simulation models or design the lab tests and analyze the test data. We welcome our clients to bring their challenges to our attention and work together to find the improvements.

[2] For more information about BitCan's integrated capabilities, please visit www.bitcange.com.