

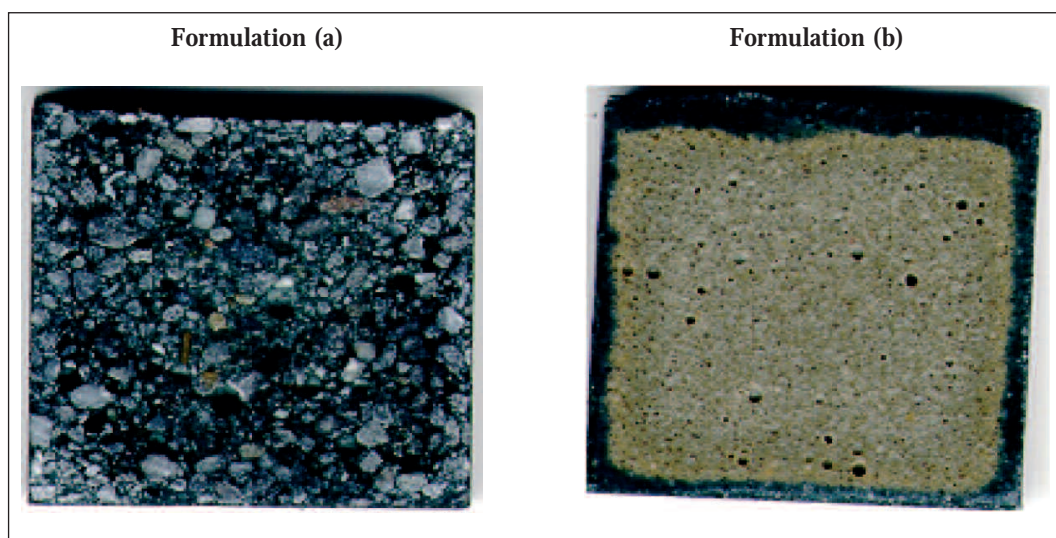
# WAOE

## Well Abandonment

### OBJECTIVES

The objective of each abandonment is to protect the remaining reserves and the environment (in particular water reserves) and to limit fluid movement within the well bore until nature restores the pressure balance that existed before the well was drilled. Concerning the barrier

materials, the main requirements are long-term integrity and low permeability. The objectives of the JIP are to define criteria for formulating new plugging materials with appropriate mechanical properties and for demonstrating the long-term reliability of materials used to plug wells.



Photographs of cement-based materials aged in harsh environments (hydrocarbons, H<sub>2</sub>S, CH<sub>4</sub>, sea water) at 120°C and 7 MPa.

## PROGRAM

### ■ Phase 1

After the cessation of production and the well abandonment, various processes resulting from variations of downhole conditions lead to stress changes within the cement sheath and cement plugs. Stress variations are the cause of damage to the cemented zones. Cement plugs can fail either by micro-annulus formation or by cement cracking depending on the variations of downhole condition. Thus, for the design of new plugging materials, the question is: what mechanical properties should a cement have to avoid micro-annulus formation or cement cracking? The objectives of the first phase of this JIP are to calculate the loading on the wells and then to define optimum cement mechanical properties. A reservoir simulator and a geomechanical model can be coupled to compute the mechanical load applied to the well. This load can then be used in a finite-element software

program to analyze the behavior of the plugging material. This last step will give target values for mechanical parameters (Young's modulus, compressive and tensile strengths, etc.) to avoid damage to cement plugs.

### ■ Phase 1 bis

The well bore stress model developed by IFP could be integrated in user-friendly software for use by the partners themselves.

### ■ Phase 1 ter

We propose analyzing the risk of plug/rock de-bonding during abandonment and making recommendations on the plug/rock interface to prevent plug/rock de-bonding.

### ■ Phase 2

During the second phase of our project, plugging materials will be cured and stored at controlled pressure and temperature in aging cells. After setting, plugging-material cores will be aged in contact with a mixture of

aggressive chemicals (hydrocarbons, H<sub>2</sub>S, etc.). At fixed periods (6 months, 12 months, and 18 months), plugging-material performance will be measured and the structure of the materials characterized. The final objective is to understand the aging mechanisms of plugging materials in order to predict the lifetime of plugs in permanently abandoned wells.

## DELIVERABLES

- Target values for mechanical parameters (Young's modulus, compressive and tensile strengths, etc.) to avoid damage to cement plugs.
- User-friendly software to test sealing materials; recommendations on plug or interface properties to prevent plug/rock de-bonding after well abandonment.
- Plugging materials aging mechanisms in order to predict the lifetime of plugs in permanently abandoned wells.

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*The information contained in this document are not contractual.*



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