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Scientific note

Effectiveness of the Acidizing Treatment in Wells Based on the Petrographic Results of Thin-Section Acidizing Experiments

1st ISPG PROCEEDINGS

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Ključne riječi: kiselinska obrada mikroskopskih izbrusaka, petrografske analize, topivost minerala.

Abstract

The acidizing treatment is a method usually used for the enhacement of productivity in oil-gas fields. Treating thin-sections for microscopic petrographic analyses with common acids, establishes the solubility and dispersion of minerals, as well as secondary formation damage. The best results were achieved by treating carbonate rocks and rocks with carbonate constituents. Siliceous minerals, such as quartz and micas are not dissolved, but the solubility of feldspars increases with the Ca-component in plagioclase and the degree of alteration. Clay minerals are subject to mechanical disintegration which causes further formation damage. Anhydrite and opaque minerals are insoluble.

Sažetak

Kiselinska obrada stijena je metoda koja se koristi za poboljšanje produktivnosti naftno-plinskih polja. Tretiranjem izbrusaka za mikroskopske petrografske analize odgovarajućim kiselinama utvrđena je topivost minerala kao i naknadna oštećenja formacija. Najbolje rezultate topivosti pokazuju karbonati. Silikatni minerali poput kvarca i tinjaca su netopivi, dok se topivost feldspata povećava sa sadržajem Ca u plagioklasima i stupnjem alteracija. Topivost glina je upitna zbog njihove disperzivnosti u dodiru s otapalom. Anhidrit i pirit su netopivi.

1. INTRODUCTION

This method contributes to the better understanding of the effectiveness of the acidizing treatment in well formations, by using the acidized thin-sections for microscopic petrographic analyses. No similar method has been found in the literature.

Depending on the mineral composition, thin-sections were acidized with hydrochloric acid and with a mixture of hydrochloric and hydrofluoric acids which are mostly used for treatment (BJ. HUGHES Inc., 1972; FARLEY et al., 1970; GDANSKI & SHUCHART, 1996). The main reason for thin-section acidizing is the variable mineral composition of sections within the same rock sample. With acidizing treatment of thin-sections the solubility of minerals is directly demonstrated as well as the secondary effects caused by the acids.

Although this treatment is mainly used for enhancing permeability in sedimentary rocks, metamorphic and effusive rocks were also treated. A few examples from the results are represented.

2. PROCEDURE

Thin sections were prepared from the rocks of different wells (i.e. different types of sandstones, dolomite with anhydrite, andesite-basalt and garnet mica schist), using conventional methods. An acidproof resin was chosen for preparation. The samples were treated under laboratory conditions, according to standard methods for solubility (API-56) where the temperature, the time of treating, type and concentration of acid were satisfied, while the pressure and influence of pore fluids were not. For thin-section acidizing two acid solutions were used which are frequently practiced in Laboratory of INA Naftaplin: 15% HCl for carbonates and 3% HF + 12% HCl for silicates. Each thin section is separately immersed in the appropriate heated solution depending on the mineral composition at a temperature of 60°C for approximately 30 minutes, and then immediately microscopically re-analyzed and photographed, so that the influence of acids on the minerals can be determined. This procedure was applied for the first time in the Laboratory of INA-Naftaplin.

3. RESULTS

Comparison of the petrographic analyses is given on Table 1.

It is obvious that metamorphic rocks predominantly composed of quartz and micas are practically insoluble (Plate I, Fig. 1). Penetration of acids is only possible along the open or carbonate cemented fractures. This is confirmed in the Gr-1Z well, where the increased productivity after acidizing is mainly connected with dissolution of the carbonate reservoir rocks.

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Minerals	Solubility in 15% HCl	Solubility in 12% HCl + 3%HF
Quartz	-	no
K-Feldspar	-	low to moderate
Plagioclase	-	low to high
Micas	-	no
Clays	-	low to moderate?
Sulfates (anhydrite)	no	-
Pyrite	no	no
Calcite, dolomite	high	high

Table 1 Solubility of minerals according to results of petrographic analyses.

The solubility of feldspars increases with the Ca-component in plagioclase and the degree of alteration. This is well documented by microphotographs of trachyandesites (Pl. I, Fig. 2), from the oil-field Crnac, so the acidizing treatment should probably improve reservoir productivity.

To enable the correct determination of clay solubility, additional SEM analyses are recommend as the magnification of the petrographic microscope's optical system is too low, and further more clay minerals are subject to mechanical disintegration and dispersion in contact with solution. This property of pelitic sediments very often cause formation plugging (BJ. HUGHES Inc., 1972). Carbonate minerals show an excellent reaction with the 15% HCl solution whether as primary or secondary constituents in rocks (Plate II). Anhydrite is not dissolved in 15% HCl, but associated with dolomite it disintegrated after the dolomite dissolved (Plate II).

Acidizing sandstones enlarges the pore space and increases the productivity of the reservoir, but also destroys the rock texture. With HCl all carbonate components (cement and detritus) are dissolved (Plate II, Fig. 1). Hydrofluoric acid partly dissolved and dispersed both the clayey matrix and coating. "Matrix free" insoluble grains may be released and collapsed, causing the formation damage.

Opaque minerals e.g. pyrite and ilmenite are mainly resistant (Plate I).

4. CONCLUSIONS AND RECOMMENDATIONS

The results indicate that acidizing treatment with hydrochloric acid is completely sufficient for carbonate rocks, and in clastic sediments cemented by carbonates, as well as for clastic sediments with high contents of carbonate detritus (rock fragments, fossils, etc.), i.e. in lithic arenites, calclithites and calcarenites. In "dirty" sandstones (graywackes) with a matrix mainly composed of a microcrystalline aggregate of quartz and sericite, clays, sodic plagioclase etc. acidizing with mixture of hydrochloric and hydrofluoric acid seems to be rather ineffective than useful. The acidizing treatment is also recommended in strongly tectonized nonsedimentary rocks with a high fracture porosity or with vesicular "porosity" as in effusives.

For the comprehensive effectiveness of acidizing treatment is important to be familiar with the mineral composition, structure and texture of the rocks and to use the described procedure for checking the effects of solubility on treated rock wherever possible.

5. REFERENCES

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PLATE I

Fig. 1 Garnet mica schist (crossed nicols). a) Thin section before treatment (Q-quartz, Plg-plagioclase, Py-pyrite, T-micas); b) There are no visible changes on minerals after acidizing treatment (12% HCl + 3% HF).

Fig. 2 Trachyandesite (crossed nicols). a) Phenocryst and microlites are composed of plagioclase with potassium feldspar (Plg+K-Fl); b) All minerals are dissolved (12% HCl + 3% HF).

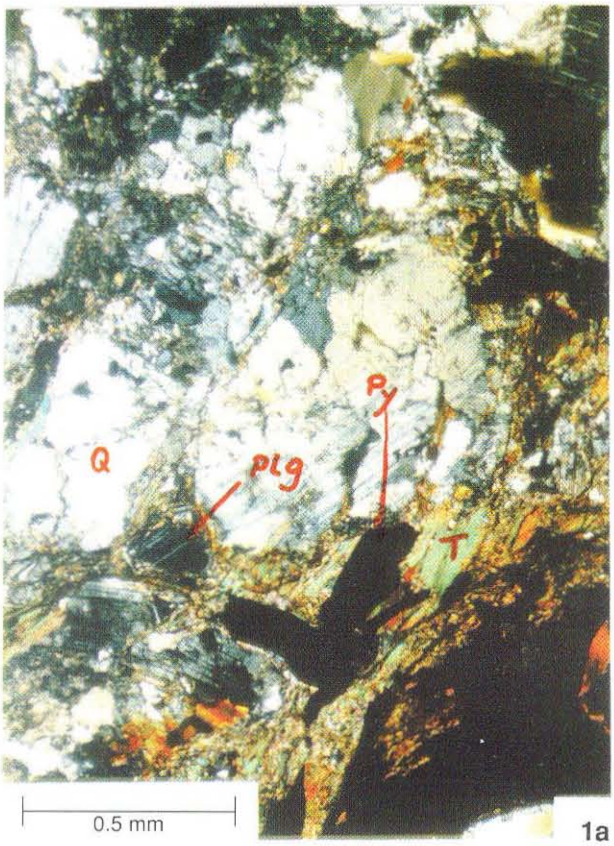
PLATE II

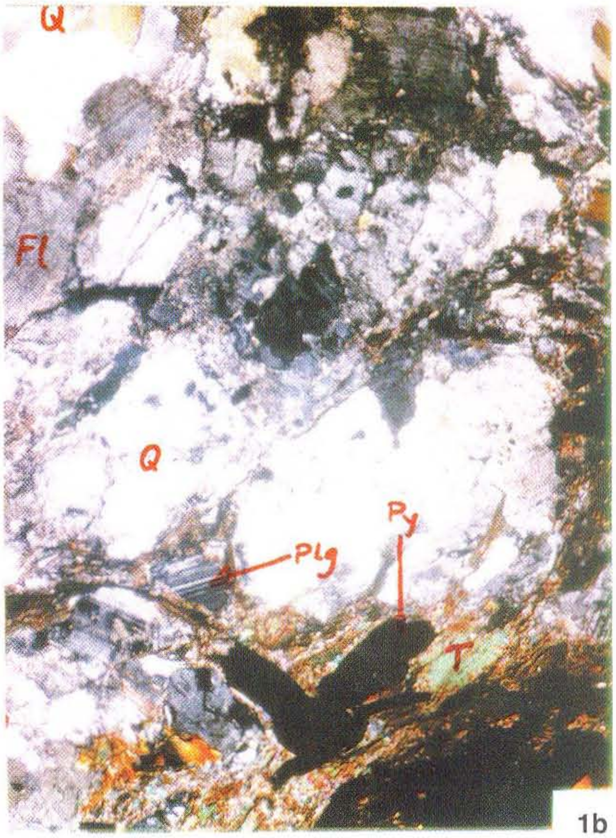
Fig. 1 Fossiliferous sandstone (litharenite) (crossed nicols). a) Detrital quartz (Q), plagioclase (Plg), lithic fragments (L-fr) and fossil remnants (F) with calcite cement (CaC); b) Only the carbonates (detritus and cement) are dissolved (black space). Acidized with 15% HCl.

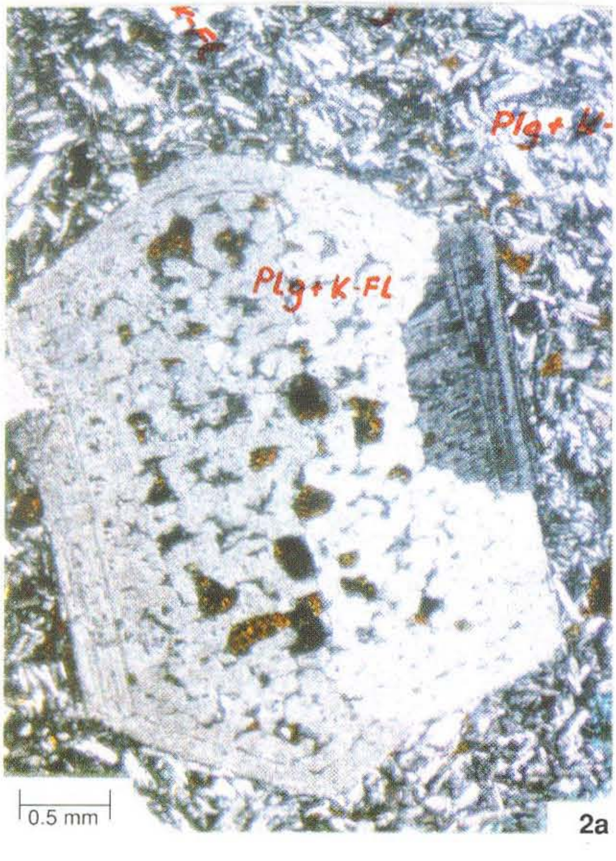
Fig. 2 Dolomite with anhydrite (crossed nicols). a) Anhydrite (Anh), dolomite (dol); b) Dolomite is dissolved (black space), and anhydrite is dispersed. Acidized with 15% HCl.

BEFORE TREATMENT

AFTER TREATMENT







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