The main mechanism in oil recovery processes using surfactants is to reduce the surface tension at the interface between the displacing and displaced liquids to very low values, at which capillary-retained oil becomes mobile (see Fig.2). Over time, the films between the foam bubbles become thinner due to the liquid draining, the bubbles burst, the foam breaks down and, finally, instead of the foam, one liquid phase remains - a solution of the foaming agent in water or other liquid.

Conclusion

Main factors influence surfactant adsorption, including (i) surfactant characteristics. Types of anionic, cationic, zwitterionic, and nonionic surfactants with different head groups, such as sulfonate and sulfate groups. Surfactant mixtures, surfactant structures with various functional groups, linear chain or branched chain, and surfactant concentrations; (ii) solution chemistry, i.e., solution pH, ionic composition with monovalent and divalent cations, hardness and salinity; (iii) rock mineralogy referred to sandstones, carbonates, and unconventional shales; (iv) and reservoir temperature. In an effort to mitigate surfactant adsorption, various additives and chemical formulations have been proposed with the addition of alkalis (strong alkalis, weak alkalis, and organic alkalis), polymers, nanoparticles, co- solvents, ionic liquids as well as implementing with salinity gradient and low salinity water flooding strategies. Finally, current trends and future challenges in alkalis, sacrificial agents, nanofluids injections, at high salinity and high temperature conditions for surfactant based EOR are outlined, which significantly improve our knowledge in designing and optimizing CEOR with reduced surfactant loss.

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TELLURIDES IN THE ORES OF THE ABYZ GOLD-PYRITE DEPOSIT (CENTRAL KAZAKHSTAN)

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The Abyz birthplace is located at the production site of Central Kazakhstan in the Karaganda region, 30 km west of the Kentyube mine. The geological structure includes devonian volcanogenic-sedimentary deposits intruded by intrusive and subvolcanic formations of medium-basic composition. According to previous works [1], two types of ores are widespread at the deposit: solid and disseminated.

The ores of the Abyz deposit are difficult to enrich. Their technological persistence is conditioned by close mineral intergrowth of copper and zinc, with pyrite and rock-forming minerals, a variety of textural and structural features and a complex composition. The average content of gold in ores is 6.6 g/t, silver - 64.6 g/t.

In the course of scientific work using the Tescan Vega 2 SBU device with a thermionic tungsten cathode, a large number of tellurides were discovered, namely: calaverite, petzite, hessite, altaite, chenguodaite, racligite and tellurobismuthite.

Gold is present in mineral form, the predominant amount, which is associated with electrum, is less common in the form of native. About 16% of gold is represented by tellurides (Table 1).

Table

Gold mineralization in ores of the Abyz deposit

Mineral form of gold	Percentage, %
Electrum AgAu	60 %
Native gold Au	24 %
Calaverite $AuTe_2$	12 %
Petzite Ag_3AuTe_2	4 %

The more common gold telluride in ores in terms of its chemical composition (Au = 40-43 %, Te = 57-60 %) is represented by calaverite $AuTe_2$. The detected inclusions of oval grains do not exceed 1.5 microns in size. The surface image (Fig. 1) shows that the grains are “overlaid” on pyrite, that is, they belong to a later stage. The rare mineral petzite Ag_3AuTe_2 (Au=25-26 %, Te=32-33 %, Ag=41-42 %) was also found in ores in the form of irregular inclusions with a dimension of about 1.45 microns (Fig. 2).

In the process of studying ores, silver tellurides in addition to gold tellurides were identified. With their chemical composition they are represented by hessite Ag_2Te (Ag=62.84 %, Te=37.16 %). The mineral was found as isometric grains, concentrated mainly in pyrite (Fig. 3) and chalcopyrite. Their dimension does not exceed 2.5 microns.

In the course of the work, in addition to the tellurides described above, altaite, chenguodaite, raclidite, and tellurobismuthite were also found.

Altaite (PbTe) is found as irregular grains in pyrite, as well as in chalcopyrite and at the boundary between pyrite and chalcopyrite. The dimension of inclusions is from 5 to 21 microns (Fig. 4). Occasionally, altaite is presented in pyrite grains together with hessite.

Chengguodayite $Ag_9FeTe_2S_4$ is predominantly developed in solid ores. Irregular grains, up to 8.5 microns in size, develop in chalcopyrite. Based on surface images, it can be concluded that chenguodayite develops mainly along microcracks and voids. Chemical composition: Fe = 3.97 %, Ag = 68.77 %, Te = 18.05%, S = 9.21 %.

Rakligite $(Bi,Pb)_3Te_4$ is found in disseminated ores in the form of irregular segregations 8-17 microns in size, filling voids in pyrite. Chemical composition: Bi = 41.39 %, Te = 44.93 %, Pb = 13.68 %.

Tellurobismuthite Bi2Te3 is found in ores as irregular inclusions in pyrite grains. The dimension of the mineral reaches no more than 8 microns and is presented as emulsion precipitates in pyrite, that is, it belongs to a later phase.

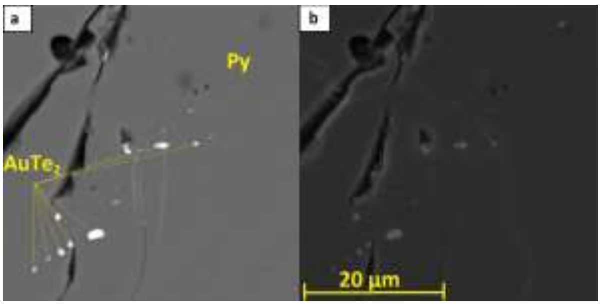

Fig. 1. SEM image in backscattered (a) and secondary (b) electrons, showing grains of calaverite ($AuTe_2$) in pyrite (Py)

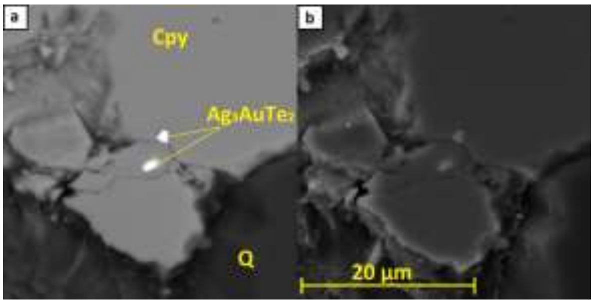

Fig. 2. SEM image in backscattered (a) and secondary (b) electrons showing irregular grains of petzite (Ag_3AuTe_2) in chalcopyrite (Cpy) in association with quartz (Q)

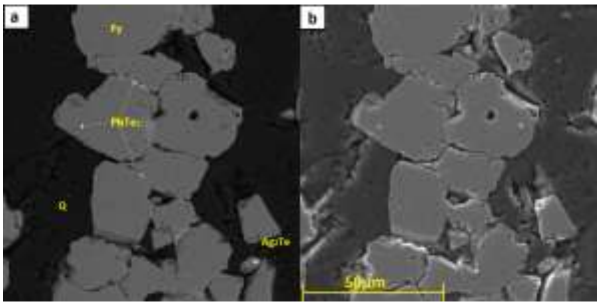

Fig. 3. SEM image in backscattered (a) and secondary (b) electrons, showing irregular hessite (Ag_2Te) precipitates in pyrite (Py) grains in association with altaite (PbTe) in pyrite voids

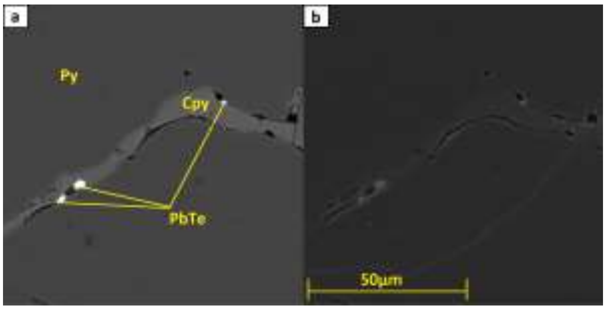

Fig. 4. SEM image in backscattered (a) and secondary (b) electrons, showing incorrect segregations of altaite (PbTe) in chalcopyrite (Cpy)

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