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# H<sub>2</sub>S Detection While Drilling A New Approach

**G**EOLOG presented a paper entitled “H<sub>2</sub>S detection while drilling: a new approach” at the 14<sup>th</sup> Offshore Mediterranean Conference and Exhibition in Ravenna, Italy, March 27-29, 2019. The paper illustrates the potentialities of the alternative methodology GEOLOG is proposing for H<sub>2</sub>S detection onsite, based on core or cutting analysis.

Whether it is oil or gas bearing, conventional or unconventional, when a field contains H<sub>2</sub>S above a certain value it is qualified as sour. Even though it presents several difficulties, the development of sour (rich in H<sub>2</sub>S and CO<sub>2</sub>) oil and gas fields is quickly emerging as a major industrial and technological theme. Such interest for sour resources arose because of two main factors: first, the diminishing accessibility of easy-to-produce conventional oil and gas makes attractive also the development of high H<sub>2</sub>S fields; second, there has been an increase of operations in areas traditionally rich in sour resources like Russia and the Middle East (Figure 1).



Figure 1. Source: Eni, World Oil and Gas Review, 2016. Annual statistic report on world reserves: crude production quality based on data from 2015

H<sub>2</sub>S detection, together with the identification of formations and well intervals bearing it, is therefore crucial for oil companies since it heavily impacts completion strategies and field development. For many years, inorganic scavengers were used and through mud acidification it was possible to release H<sub>2</sub>S and to get an evaluation of its concentration. Nowadays, the use of organic scavengers which bound irreversibly to H<sub>2</sub>S, makes impossible its detection and hinders all the information regarding well sourness.

In this paper, GEOLOG have presented a novel methodology which aims at overcoming this problem by core/cutting analyses. Methodology development started from the hypothesis that part of the formation gas is still preserved in cutting pores. Experimental evidences, collected in the last few decades, show that gas (hydrocarbons and contaminant gases, including H<sub>2</sub>S) is mostly released by the rocks while drilling into mud (so-called mud gas); nevertheless, some further gas can be released by cuttings e.g. in sealed vials (so-called head space gas) and, finally, a last portion is still preserved in cuttings. Our experimental approach implies the analysis of this last portion, also called interstitial or residual gas, that can be recovered by grinding the cuttings in a sealed mill, gas recovery from the gastight chamber and its analysis by GC-TCD H<sub>2</sub>S detector (Figure 2).

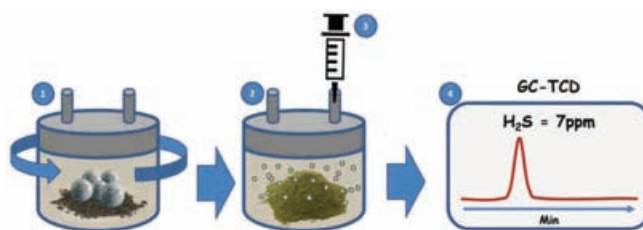


Figure 2: Sketch of interstitial gas operating procedure. 1) Dried cuttings are placed in gas tight agate container; 2) Once mill to fine powder residual gas is released and 3) Sampled through a gastight syringe or directly connected to a GC-TCD detector 4) where H<sub>2</sub>S is quantified.

It must be highlighted that the obtained H<sub>2</sub>S concentration value is not only depending on its abundance but also on many other concurring factors which are difficult to precisely evaluate and quantify, such as rock permeability, sample preservation and treatment and rock-gas interactions. Therefore, the detected concentrations cannot be interpreted on a strict quantitative basis, but they still give us an important indication of H<sub>2</sub>S presence and of its relative abundance.

In one of the first successful applications of these methodology, a sandstone reservoir in South-West Africa has been subjected to investigation. The analyzed interval was comprehending 600 meters of the horizontal drain of the exploration well. Oil base mud was used

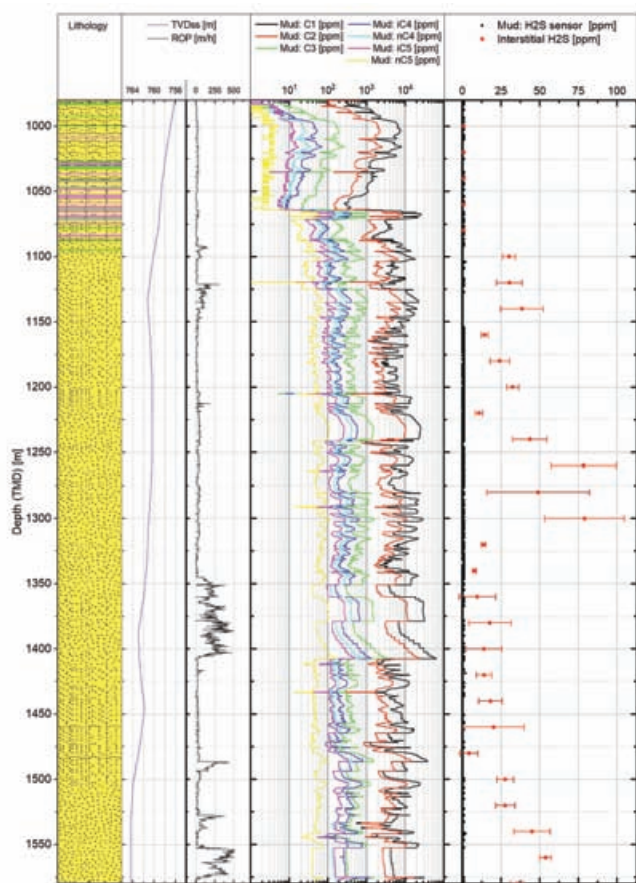


Figure 3: Depth log of mud gas and Interstitial gas analyses of a sandstone reservoir section. Results are displayed vs total measured depth (TMD). 1<sup>st</sup> col.: lithology; 2<sup>nd</sup> col.: total vertical depth (TVD); 3<sup>rd</sup> col.: rate of penetration (ROP); 4<sup>th</sup> col.: mud gas hydrocarbon data, from methane (C1) to pentane (C5), with isomers; 5<sup>th</sup> col.: mud gas H<sub>2</sub>S from mud logging sensors and interstitial H<sub>2</sub>S (with associated error bars).

as drilling fluid, without any addition of H<sub>2</sub>S scavengers. At the time the well was drilled, mud gas logging was employed, among its other tasks, in order to keep H<sub>2</sub>S abundance monitored for safety reasons. Since the well spud, deployed electrochemical sensors registered a

signal oscillating from 0 to 1ppm, as first hint that H<sub>2</sub>S was potentially present in the drilled formation. Later on, once finished drilling, downhole fluid analysis confirmed that the reservoir was producing gas with 1% (mol) of H<sub>2</sub>S. In order to test the applicability of the methodology described in this paper, the cuttings coming from this well were requested to be analysed, almost two years later since the well was completed. Cuttings from 600 meters of the reservoir horizontal drain were analysed for interstitial gas with a 20m frequency. Results are shown in *Figure 3*.

Hydrogen sulfide was detected below the dolomitized section in variable concentration through all the reservoir. Being one of the very first applications of this methodology, H<sub>2</sub>S presence and abundance was confirmed by repeating three times the measurement on the same cutting sample (its concentration is reported together with the associated standard deviation). The variability of the magnitude of H<sub>2</sub>S could be due to different reasons, among which sample heterogeneity has been identified as the possible major contribution. Knowing that cutting dimensions could influence the capability of the rock sample to store the gas in its pores, it was found very interesting that the use of a PDC bit caused the analysed cuttings to be in the state of fine/medium disaggregated sandstone and yet H<sub>2</sub>S was still preserved in these samples.

These results are the proof that the methodology can be not only applied even on several years old cuttings, but also on very small size cutting samples, i.e.: PDC bits are not a limitation for this methodology.

Other case histories were included in the paper in order support the presented methodology and shed light about the potentialities of such kinds of analyses. Although this methodology can be exploited at its best in combination with petrophysics analyses, it can still provide unique pieces of information about H<sub>2</sub>S distribution through drilled formations. In fact, the possibility to discriminate H<sub>2</sub>S abundance though a reservoir in near real time could be used, for example, to help in selection of kick off points for horizontal drains or when programming the well completion in the packers positioning. **Pa**

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