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SPE

ITALIAN SECTION

TECHNICAL BULLETIN 2 / 2017

THREE DAYS AT THE 13TH OFFSHORE MEDITERRANEAN CONFERENCE AND EXHIBITION

A NEW EXPERIENCE FOR SPE ITALY AT THE INTERNATIONAL VALVE SUMMIT

AN IMAGINARY (BUT NOT ENTIRELY) CONVERSATION WITH MARK ZUCKERBERG

Fig.1: Bianca Cecconi (Geolog International), Best Paper for Technical Content at OMC 2017

HELIUM DETECTION AT WELLSITE: A POWERFUL GEOCHEMICAL TOOL

ANDREA LAMBERTI
Eni S.p.A.
SPE Italian Section
Reservoir Technical Director

Dear members,

O&G industry is fighting to fit a 50$/bbl era: almost all the IOC are continuously pushing to minimize costs to make projects economically robust.
Data collection is one of the most common sacrificial victim, often cut from project budgets to lift the NPVs.
As reservoir engineers, we suffer the lack of data, especially during the first development phase of a project, to support decision making and tune our models. It can be frustrating when bosses ask for robust predictions without investing enough in data collection: "There is no free lunch!"
Therefore, we have to find out solutions to maximize the value of already available information: mud logging is one possibility, providing representative information about the lithology and fluid content of the formation while drilling and on site.
Indeed, new developments are providing mud logging analyses with more and more information about our reservoir that can support real-time decision making with a relatively limited investment.
The following text is an adaptation of a bigger work presented at OMC2017

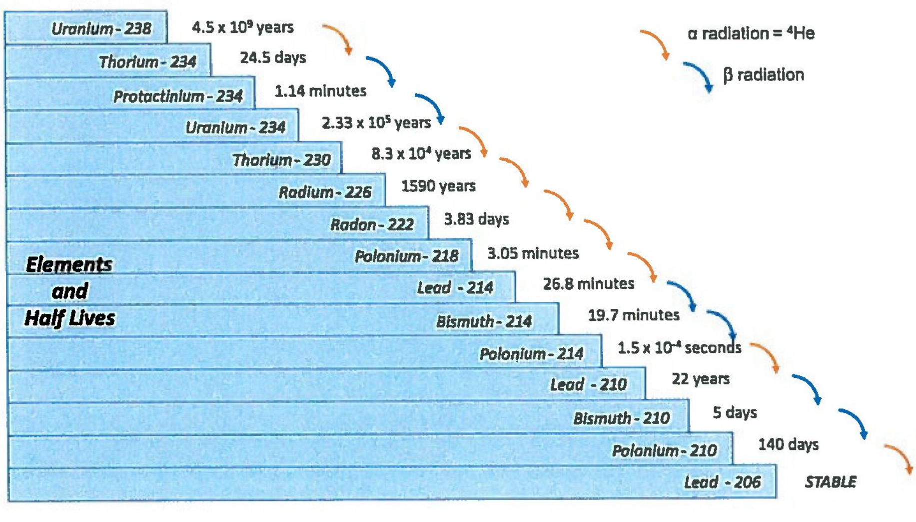

Fig.2: Radioactive decay chain for Uranium-238.

written by Bianca Cecconi and Isaac Easow (both working for Geolog International).

HELIUM DETECTION AT WELLSITE: A POWERFUL GEOCHEMICAL TOOL

Noble gases are precious markers for natural fluid characterization. The common feature amongst all these gases is their chemical inertness; as they are generated, only physical processes govern their migration and isotopic fractionation (Fig.1).

This article focuses on wellsite detection of the smallest noble gas, i.e. helium, in the isotopic form of 4He. The main challenge of helium measurement is to find a compromise between having analytically reliable results at wellsite and using robust instruments, capable of working in non-standard situations such as a mud logging laboratory.

The origin on the Earth's crust of Helium-4 is related to the radioactive decay process of some elements, such as Uranium and Thorium, for example fig.2 shows the decay chain for Uranium-238 that involves the emission of several α particles, Helium-4 atoms, indicated by orange arrows. The main interest in Uranium logging is related to the oxygen-free conditions in which it precipitates in the redox state of Uranium (IV). Such anoxic conditions are also the necessary environment for organic matter deposition and transformation to give hydrocarbons. As helium is generated from uranium radioactive decay, its presence is indirectly correlated to the possible presence of organic matter and for that reason it is considered a proxy for hydrocarbons. At the same time, being helium the smallest gas present in a formation, its concentration can be correlated to permeability and fracture presence (Fig.2).

The main advantage of having wellsite analyses relies on the representativeness and density of samples that can be recorded: the mud gas composition is the closest to the real concentration of the gas coming from the drilled formation and the sampling interval is related only to the turnover time of the instrument resulting in highly detailed logs.

If samples need to be collected and shipped in laboratories far away from the rig, there are issues arising in the collection, storage and shipping procedures that can introduce errors and potential leaks. Moreover, the time response could rise till weeks or months after reaching TD, ruling out any use of such measurements in real-time decision making.

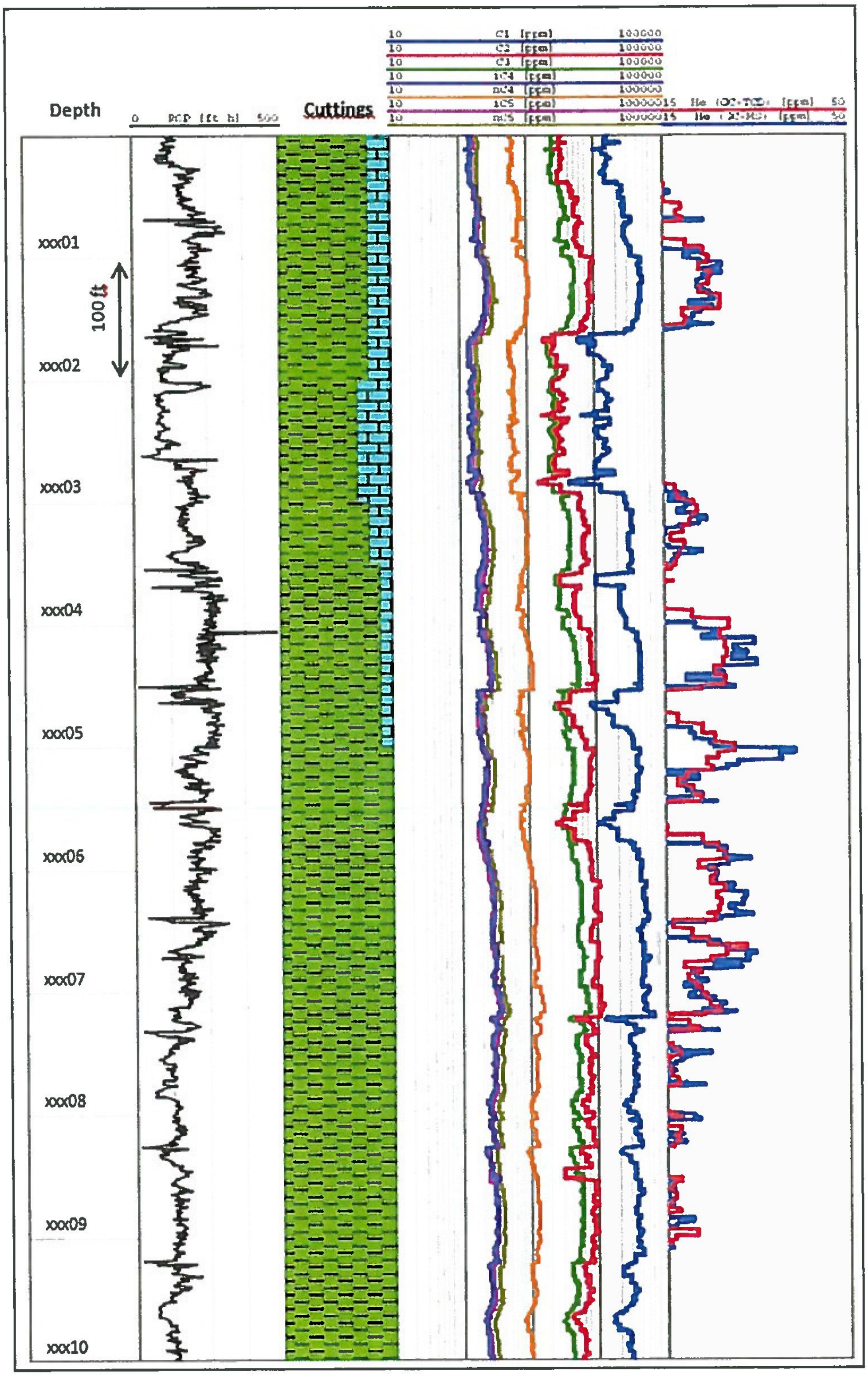

Fig.3: Helium logs comparison between TCD and MS readings.

The article illustrates first the field performance comparison of two technologies for helium detection and then the case histories regarding the use of helium logs in integrated interpretations for permeability/fracture patterns identification and possible hydrocarbon proxy (presence) in unconventional fields.

TWO TECHNOLOGIES ON THE FIELD: µTCD AND MASS SPECTROMETER

Straightforward-to-use and difficult-to-fail instruments are at the basis of a winning solution to get reliable results from wellsite analysis.

Two technologies have been compared on the field introducing the helium detectors on the mud gas line of a standard mud logging unit: single quadruple mass spectrometer and µTCD (thermal conductivity detector). According to the instrumental specifications as tested in the laboratory, the performances in

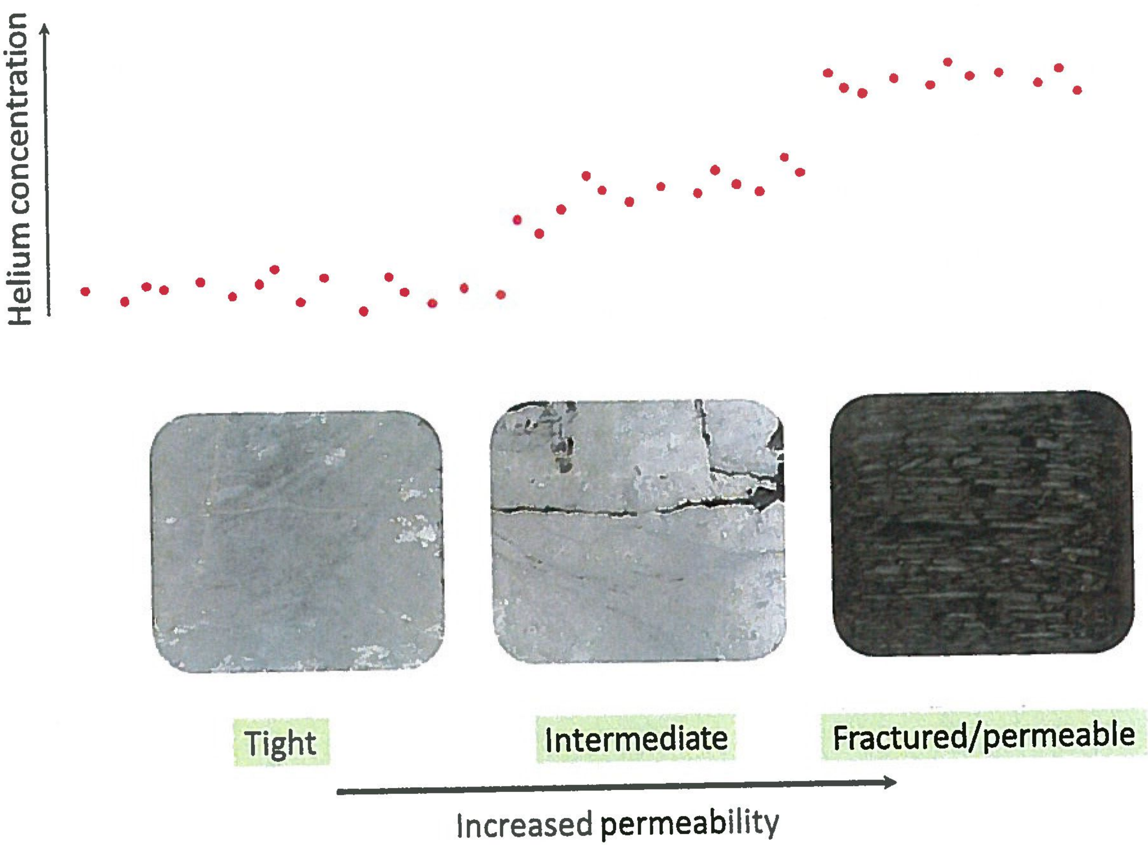

Fig.4: Schematic representation of fracture and permeability patterns and helium trends.

helium detection were likely to be similar. The two instruments have been tested on a field where the expected helium levels were in the range of 10-50 ppm, thus quite close to the instrumental limits of detection set in the laboratory. The results of the two instruments are plotted with a cut-off of 15 ppm in fig. 3 together with the C1-C5 readings, ROP intervals and cuttings description.
As it can be deduced from figure 3, there is a very good match between the two results, suggesting that both the technologies are fulfilling the parameters for good and reliable helium detection, necessary for a correct log interpretation. Not only the main helium shows are correctly matching, i.e. xxx04-xxx07, but also when concentration is lower such as in the case of xxx01-xxx02 and xxx07-xxx09.

HELIUM IN FORMATION EVALUATION

A careful interpretation of helium concentrations passes through the integration with other logs such as mud gas, geochemical and image logs, in order to confirm hypotheses and avoid misleading conclusions (Fig.3). In conventional fields, changes in formation fluids nature and compartmentalization can be correlated to helium trends, while in unconventional plays helium distribution is directly connected to the presence and abundance of radiogenic minerals. As migration is largely limited, in these tight rocks and self-sourcing environment, the helium levels can be correlated to the organic rich and frackable formations.
Two case histories will be now illustrated for unconventional fields.

• Fracture and permeability pattern detection

During the exploration of an unconventional well in the United States, helium levels have been correlated to Image Logs from downhole equipment for identification of fractures (Fig.4).
In the study, the abundance of fractures has been correlated to increases or decreases in helium levels, resulting in a good match with the fractures detected through Image Log. If the abundance of fractures from Image Log is compared to the helium concentration trends, it can be deduced that high fracture frequency is associated to higher concentration of helium, while when tight layers are present the helium content is low. As a confirmation of the observed trend, an intermediate number of fractures is validated by average levels of helium, as schematically illustrated in fig.4.

An interpretation model can be built by integrating the results from the downhole Image Log and other surface logging data as helium trends in mud gas, mineral composition of drill cuttings and drilling mud flow monitoring, that can be used to predict the occurrence of open natural fractures in future wells by running mud logging only for effective cost savings.

• Hydrocarbon proxy

Helium concentration can also be used as a proxy for presence of organic matter in unconventional wells. While drilling a horizontal well targeting the Wolfcamp formation, a well-known source rock in the Permian basin of Texas, United States, the helium peaks have been related to the presence and abundance of hydrocarbon gases, confirming that less tight formations are associated with higher ROP and higher levels of total gas and helium (fig. 5). A good correspondence between the gas shows (noble and hydrocarbon) and the lithologica description is evident when comparing the two logs. For example, the xxx01-xxx02 xxx06-xxx08 and xxx10 intervals are riche in hydrocarbon gases and helium, while the xxx02-xxx06 interval shows a drop that ca be correlated to the limestone abundance, a confirmed by the calcium behaviour from XR (fig. 5).
It is of great importance that the helium peak are positioned in the hydrocarbon rich zone and in the expected lithology, confirming th strength of the correlation and the expectatio of having the organic content higher in the shal and radioactive elements rich intervals.

CONCLUSIONS

The illustrated study on helium detectio highlighted the potential use at wellsite this noble gas. Two analytical technique have been positively tested and the field performance compared in detai confirming the robustness and reliabili for wellsite analyses for both instrument solutions.
Once the analytical reliability ha

been assessed, the role of helium measurements in formation evaluation has been described.
In unconventional fields, helium logs can be associated to two aspects:

• Changes in helium concentration have been correlated to the fracture patterns measured by downhole image logging. An interpretation model for a series of wells can be developed by integrating the helium logs to other data coming from the mud logging unit, such as the mud flow changes while drilling, or the variation in inorganic proxy concentration in the drill cuttings. This approach can lead to fracture pattern identification from mud logging when downhole logging tools are unavailable;

• Changes in helium have been also correlated to the lithological changes and are directly correlated to the presence of organic matter and hydrocarbons in the formation as migration could be limited within the self-sourcing rock.

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Bianca Cecconi
Bianca Cecconi graduated in Organic Chemistry at the University of Florence and got the PhD title in Material Science at the University of Milan Bicocca. She joined the R&D team of Geolog in Milan headquarter on March 2016 with the role of R&D Specialist. She is involved in both the development and optimization of new analytical instruments and the improvement of data interpretation. She is author of 7 articles published on peer-reviewed journals and member of the EAOG, the European Association of Organic Geochemists.

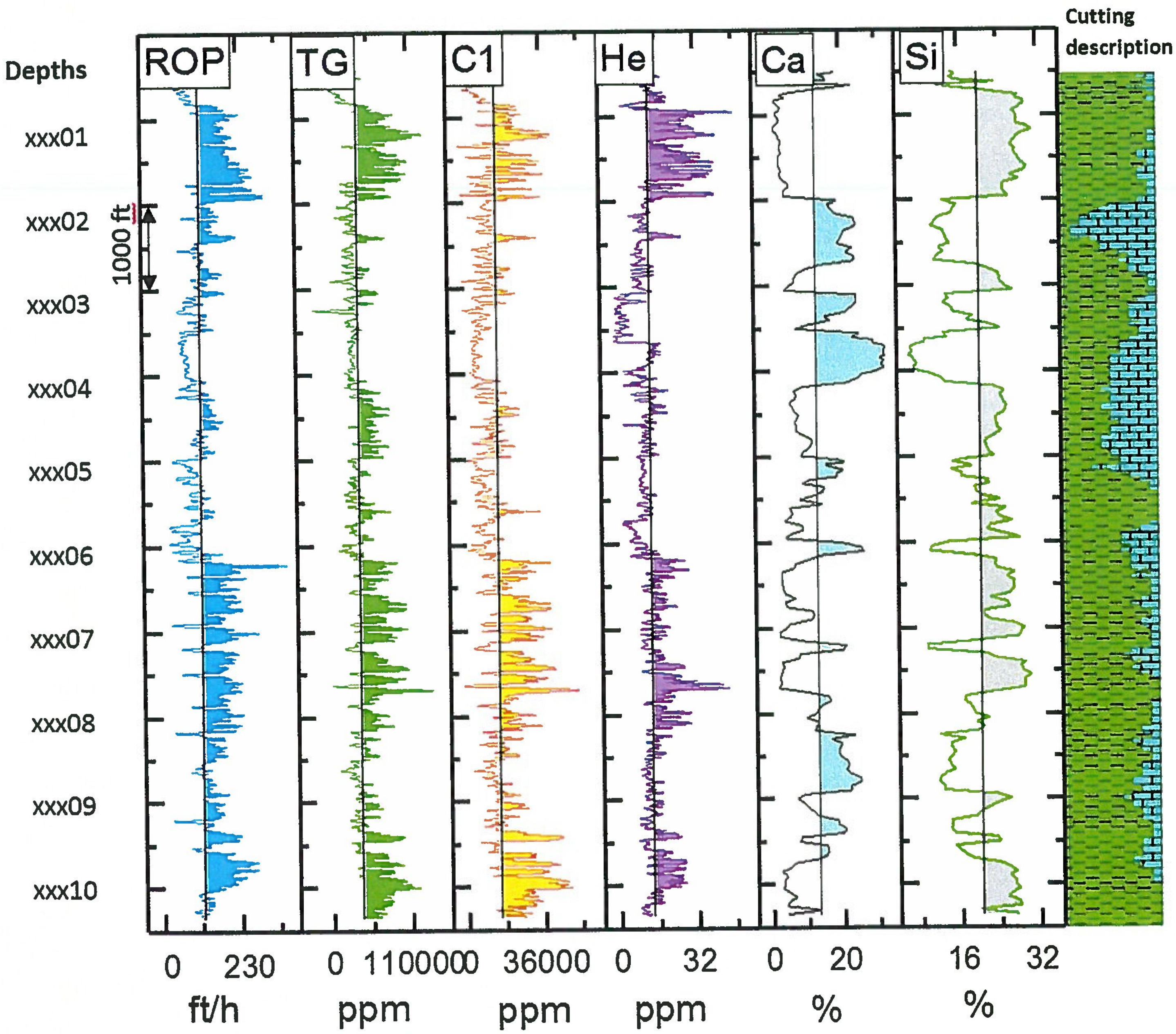

Fig.5: ROP, TG, C1, Helium and some XRF logs together with the lithological description of cuttings.