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Photomicrograph Analysis of Marcellus Well-Cuttings from Northeast Pennsylvania

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Abstract:

Often times when an oil or gas well is drilled in an area with limited geophysical and mud logs, the geologist or mudlogger describing the drill cuttings may wonder about the veracity of their work. Such an uncertainty may decrease the rate and accuracy of the mudlogging procedure, or inhibit personnel from determining how far drilling has advanced in relation to the target zone. If a descriptive guide containing photomicrographs was available early in the development of a new gas field, mudloggers would be more definitive in their analysis of cuttings. In order to test this idea, a descriptive guide was created to help with the identification of drill cuttings from a natural gas well drilled in Sullivan Co., PA, located in the Marcellus Play in northeast Pennsylvania. The well was sampled every 30' starting at a depth of 600' and ranging to 8,500' below the surface. Basic lithology types encountered during drilling and mudlogging included sandstone, siltstone, limestone and shale. Representative samples of each significant lithology were analyzed for this study. The created guide utilizes photomicrographs taken with a Motic 2300 camera mounted on a Motic polarizing microscope. Helicon Focus software was used for focus stacking. The photomicrographs have been matched with data and descriptions from the on-site mudlogs which list both formation tops and the lithological sequences. Printed color hardcopies and DVD versions of the guide will be distributed to the operator who provided the cuttings for the study. A request will be made that the operator provides feedback regarding the usefulness of the guide.

Procedure:

Varying lithologies were initially determined through the use of a mudlog, provided by Chief Oil & Gas, produced by Horizon Well Logging, LLC. Comparisons were made between the given descriptions, lithologies, and Rate of Penetration (ROP) logs. Individual well cutting samples were then analyzed using the Motic polarizing microscope in order to better identify the rock type. Once the mean cutting size and lithology was determined for each sample, individual grains were photographed under both 4x and 10x magnification for proper identification. Each image produced was comprised of ≥ 25 photographs taken using a Motic 2300 camera and compressed and focused using Helicon Focus software. Descriptions were then produced for each sample in order for comparison with the provided mudlog lithologies.

Findings:

It was determined that certain lithologies were accurately portrayed by the mudlog, but inconsistencies occurred within sandstone-siltstone sequences. All portions of the log that identified formation tops and bottoms, Tully Ls, Hamilton Sh, Marcellus Sh, Purcell Ls, and Onondaga Ls, were accurately described. The uppermost formation listed on the log was the Tully Ls, located at a vertical depth of 6100 ft. Above the Tully Ls is a series of alternating sandstone-siltstone sequences, ranging 5500 ft in length, whose compositions are relatively similar. Varying quartz, mica, pyrite, and calcite granules comprised the lithologies whose colors ranged from reddish brown to dark gray. Samples whose contents were largely sub-angularly rounded quartz grains were deemed sandstones. Particle sizes were slightly larger than those found in the accompanying siltstones. Siltstones samples commonly appeared light gray to gray, sub-rounded, and were commonly well sorted. The mudlog record varied in accurately identifying these lithologies due to their similar natures. Such conclusions are somewhat expected due to the nature of the mudlogging process and the many uncertainties encountered during drilling. During the drilling process, mudloggers must hurriedly determine the depth of drilling and lithological characteristics by taking into account “lag time,” the amount of time necessary for the cuttings to travel from the drill bit to the surface. Drilling mud as well as previously ground cuttings may also be incorporated in the samples due to the rapid progression of the drill bit (rate of penetration logs, ROP).

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Lithologic Guide

- Limestone
- Shale
- Siltstone
- Sandstone