GUIA PARA LA CLASIFICACIÓN DE RIPIO DE PERFORACION

BIT CUTTINGS NOMENCLATURE GUIDE

Hernando Pinto Rodriguez

pintoh42@yahoo.com

Pinto Rodríguez Hernando., *Guía de clasificación de ripio de perforacion - Bit cuttings nomenclature guide-,* – GEOLOGIA COLOMBIANA, Vol. 42. Bogotá, Colombia. pp. 51 - 60,

Manuscrito recibido, *2019-01.16* Manuscrito aprobado 2019-06-20

Resumen

La descripción de los cortes de broca es una herramienta importante para definir las características litológicas y mineralógicas de las rocas que se perforan. Las nuevas tecnologías de broca combinadas con parámetros de perforación dan como resultado la destrucción de la textura de la roca y la generación de morfologías particulares de cortes de broca. El propósito de esta guía es intentar estandarizar la descripción de los cortes de barrena basada en Graves W., (1986), y complementada con nuestras observaciones realizadas durante el trabajo de campo.

Palabras clave: Cortes de broca, harina de broca, cortes de broca metamorfizados, descripción de color de roca

Abstract

Bit cuttings description is an important tool to define lithological and mineralogical features of the rocks being drillings. New bit technologies combined with drilling parameters resulted in the destruction of rock texture and generation of particular bit drill cuttings morphologies. The purpose of this guide is attempt to standardize the bit cuttings description based on the Graves W. (1986), and supplemented with our observations made during the field job.

Keywords: Drill cuttings, drill flour, metamorphized drill cuttings, color description of stone

INTRODUCTION

The morphology of bit cuttings generated during the drilling has a close relationship with bit types, drilling parameters, mud weight and mud type, and lithological features. Subtle variations of any of these parameters could result in changes of the bit cuttings forms.

There is a general tendency of the people to describe bit cuttings morphology as if they had been recovered from an outcrop conducting to erroneous interpretations. The majority bit cuttings generated during the drilling are affected, so their textural features have been modified from a low grade, where sporadically it is still possible to observe some relict of the original rock texture, to a high grade where the rock texture has been totally destroyed. However, the natural features of the rock can be observed on the caving fraction and sporadically over bit cuttings.

The purpose of this guide is attempt to standardize the bit cuttings description based on the Graves W., (1986), and supplemented with our observations made during the field job.

Micro-photographs displayed here were taken using a stereo microscope Zeiss Stemi DV4 with a canon power shot SD 1300 SI camera adapted to it. To indicate the size of bit cuttings and grains in the micro-photographs a 0,5 mm pencil lead was used which is equivalent to medium

grain size in the Udden-Wentworth grade scale (1922). Rock colours were determined based on Munsell rock colour chart (2009).

BIT CUTTINGS NOMENCLATURE

It is proposed to implement the following terms to describe bit cuttings:

Bit Flour

As its name refers, bit flour is produced when the rock is pulverized and the bit cuttings have an amorphous shape with a lighter colour than the original rock colour. They have been observed during the drilling using tri-cone and impregnated bits (Figures 1, 2, 3 and 4).

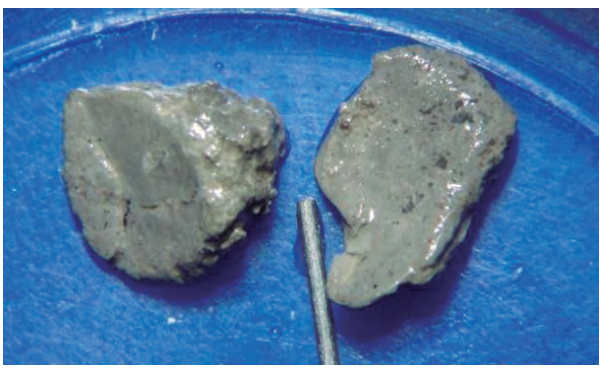

Figure 1. Bit flour of mudstone medium grey from Guadalupe Fm. Drilled with Tricone bit & WBM.

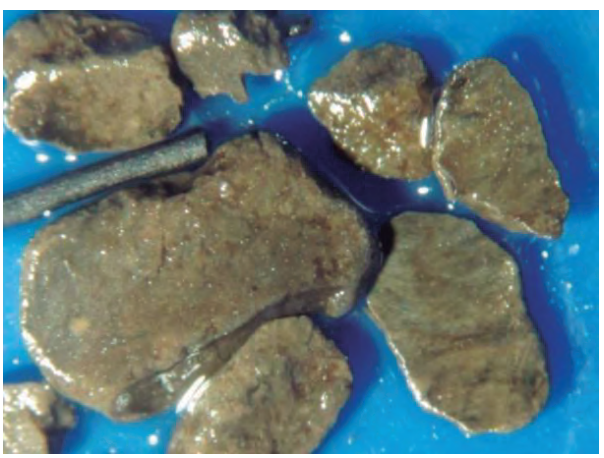

Figure 2. Bit flour of Siltstone brownish grey from Mirador Fm. Drilled with Tricone bit & OBM.

Bit flour is very common when an argillaceous section of the well is drilled with water base mud, which hydrates the bit cuttings (Figure 5), and a good part of them can be incorporated as solid to the mud system or lost during the washing operation to prepare the sample for its analysis.

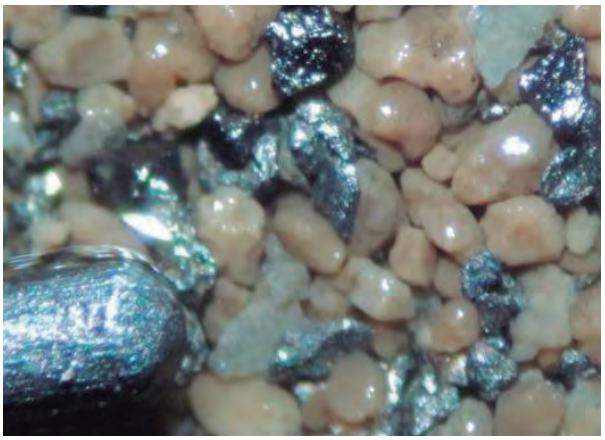

Figure 3. Bit flour of Sandstone light yellowish brown, blocky from Mirador Fm. Drilled with Impregnated bit & OBM.

Figure 4. Bit flour of Sandstone white, amorphous from Une Fm. Drilled with Tricone bit & WBM.

Figure 5. Mudstone reddish brown, moderate yellow, amorphous & blocky from Guayabo Fm. Drilled with PDC bit & WBM.

Platelets

In my opinion, platelets bit cuttings are a kind of bit flour which is generated mainly by the action of PDC bit cutters.

They have a side that is a semi-circular, polished surface that can be concave, convex or flat (Figures 6 and 7), whilst the opposite side has a ribbed or stepped appearance (Figures 7 and 8).

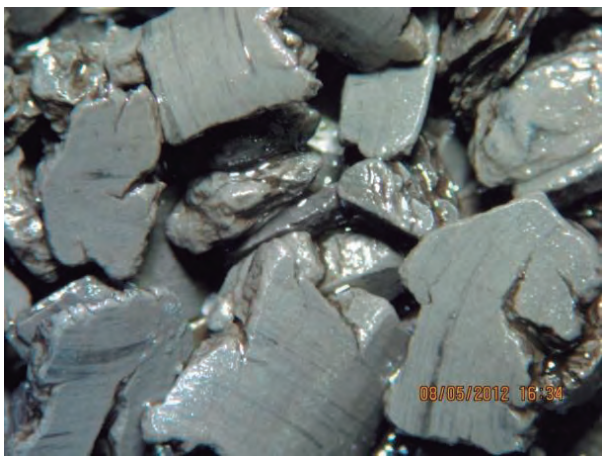

Figure 6. Mudstone medium grey from Carbonera C8 Fm. Drilled with PDC bit & OBM.

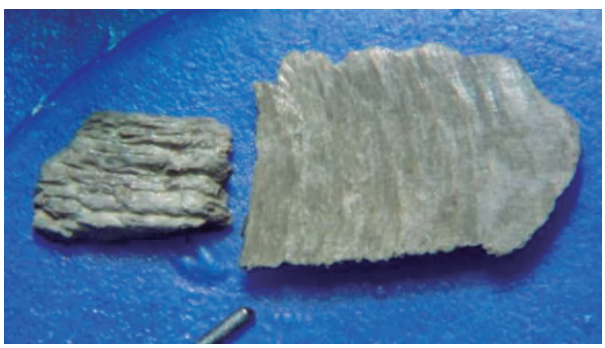

Figure 7. Mudstone medium grey from Guadalupe Fm. Drilled with PDC bit & WBM.

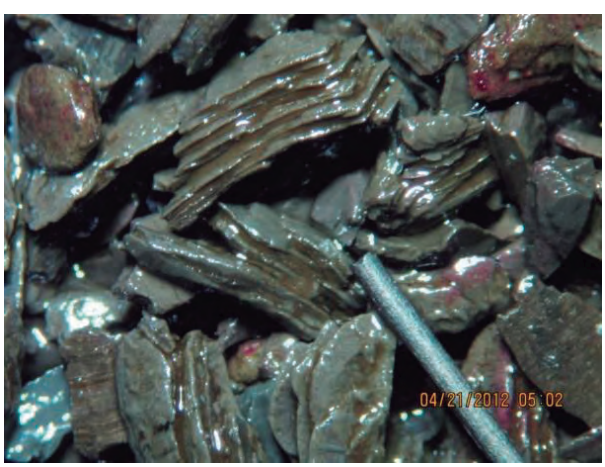

Figure 8. Mudstone medium grey from Carbonera C8 Fm. Drilled with PDC bit & OBM.

Besides, it seems that the cuttings produced close the bit nose show a tendency to have a conical form (Figure 9).

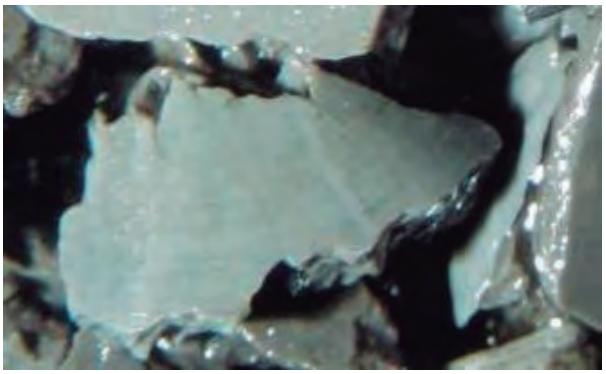

Figure 9. Mudstone greenish grey from Carbonera C8 Fm. Drilled with PDC bit & OBM.

Platelets are generated independently of lithology being drilled and almost all of them don't exhibit the original rock texture which has been destroyed (Figures 10, 11, 12 and 13).

Figure 10. Mudstone moderate brown with laminations of Sandstone pale yellowish brown from Mirador Fm. Drilled with PDC bit & OBM.

Figure 11. Siltstone yellowish brown & Sandstone greyish yellow from Mirador Fm. Drilled with PDC bit & OBM.

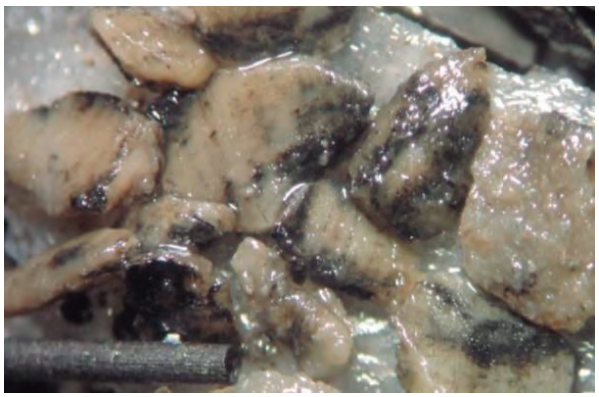

Figure 12. Sandstone white with black mottled from Mirador Fm. Drilled with PDC bit & OBM.

Figure 13. Limestone pale yellowish brown from Guadalupe Fm. Drilled with PDC bit & WBM.

In the sample trays it is possible to encounter chips of rock which have the original texture (Figure 14). Platelets occasionally can reveal the unaltered rock when they are crushed (Figure 15).

Figure 14. Sandstone (A) Translucent grey, tabular. (B) Yellowish grey, platelet, both with translucent red quartz grains. From Guadalupe Fm. Drilled with tricone /PDC bit & OBM.

Figure 15. Mudstone (A) Medium grey, platelet. (B) Dark grey unaltered rock from Guadalupe Fm. Drilled with PDC bit & WBM.

Impregnated bits eventually generate platelets but these are smaller than those produced by a PDC bit (Figure 16).

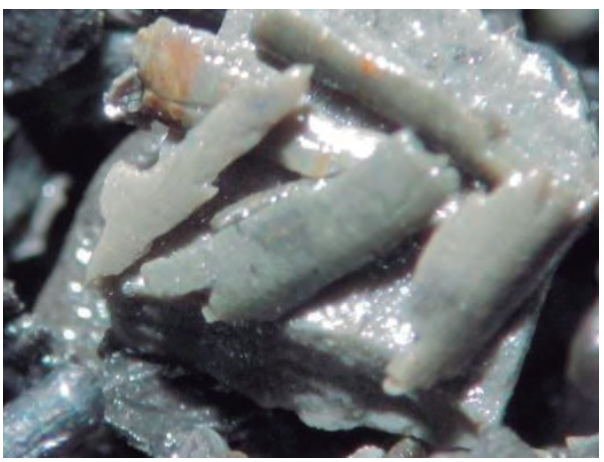

Figure 16. Siltstone light grey to white from Carbonera C8 Fm. Drilled with impregnated bit + turbine & OBM.

Metamorphic

Metamorphosed bit cuttings are produced by impregnated and PDC bits. When sandstone and siltstone sections are drilled, the rock texture can be altered from a low grade, where the bit cuttings appear in lamellas shape with a face that is grooved of dark coloured or metallic lustre (Figures 17 and 18), whilst the opposite face shows relicts of unaltered rock (Figure 19 and 20) until a high grade where the rock is pulverized and recrystallized difficulting the lithological identification of what is being drilled.

Figure 17. Sandstone greyish black with metallic lustre from Guadalupe Fm. Drilled with impregnated bit & OBM.

Figure 18. Sandstone medium dark grey with metallic lustre from Mirador Fm. Drilled with PDC bit & OBM

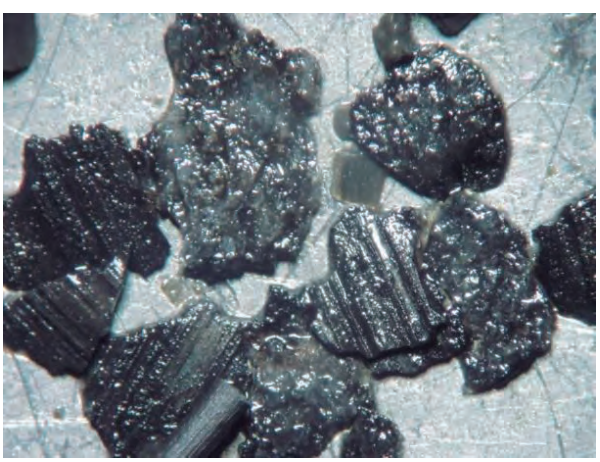

Figure 19. Sandstone dark grey with medium quartz grains relicts from Barco Fm. Drilled with PDC bit & OBM.

A way to define the lithology in metamorphosed flakes is to examine with high magnification bit cuttings borders looking for relict of grains or rock (Figure 21).

Figure 21. Sandstone black with original rock relicts at the cuttings border from Mirador Fm. Drilled with impregnated bit + mud motor & OBM.

Additionally, when a hard, well cemented sandstone is being drilled, it has been observed an apparent lack of bit cuttings. To examine sample trays taken at the shale shakers from different screen sizes and from distinct sieves sizes, it was found that bit cuttings show up as smaller dark to occasionally sub-translucent scales with a size ≤ 0,5 mm (Figures 22, 23 and 24) which can be easily lost at the shakers or when the samples are washed.

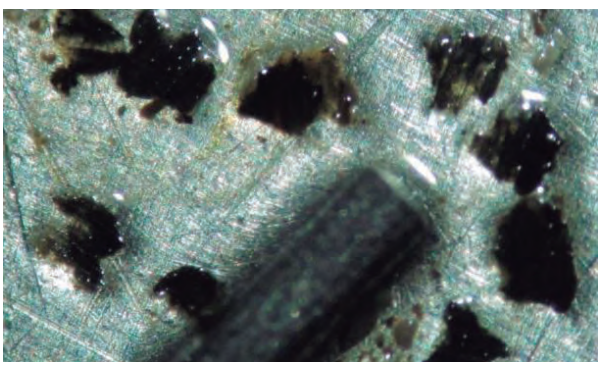

Figure 22. Sandstone black & sub-translucent from Mirador Fm. Drilled with PDC bit & OBM.

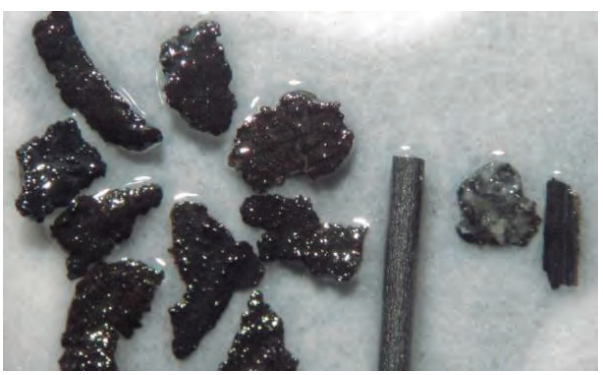

Figure 23. Sandstone black from Mirador Fm. Drilled with impregnated & OBM.

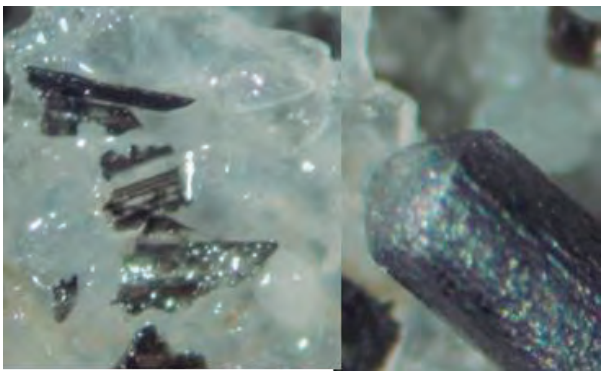

Figure 24. Sandstone dark grey with metallic lustre from Mirador Fm. Drilled with impregnated & OBM.

Metamorphosed mudstone drill cuttings appear either as grooved, wrinkled flakes or micro-banded blocks to lumps (Figures 25, 26 and 27).

Figure 25. Mudstone dark grey, grooved flakes from Mirador Fm. Drilled with PDC bit & OBM.

Figure 26. Mudstone light to medium grey with reddish brown mottled, wrinkled flakes from Mirador Fm. Drilled with impregnated bit & OBM.

Figure 27. Mudstone dark grey, wrinkled, micro-banded lumps from Guadalupe Fm. Drilled with PDC bit & WBM.

The same happens with platelets since one can find in the sample trays unaltered chips (Figure 28 and 29).

Figure 28. Mudstone medium grey. (A) metamorphosed cuttings. (B) unaltered chips from Los Cuervos Fm. Drilled with impregnated bit + turbine & OBM.

Figure 29. Mudstone medium grey with moderate red mottled, metamorphics & platy from Los Cuervos Fm. Drilled with impregnated bit + turbine & OBM.

The unexpected presence of metamorphosed bit cuttings could be an indicative of bit wear, but it should be analysed carefully and confirmed by monitoring drilling parameters (e.g. changes in torque and stand pipe pressure behaviours).

ROCK PRIMARY COMPONENTS AND ACCESSORY MINERALS

Rock primary components and accessory minerals are also affected by the work of the bit cutters. Likewise, they can be destroyed and they appear on the bit cuttings surfaces as streaks, mottled or speckles difficulting their identification (Figures 30, 31, 32, 33, 34 and 35).

Figure 30. Sandstone pale yellowish brown with black & white streaks due to quartz & lithic grains from Mirador Fm. Drilled with tricone/PDC bit & OBM.

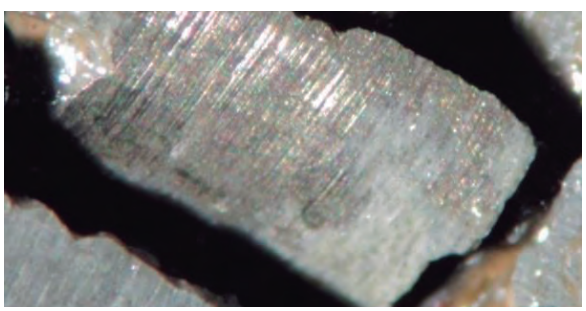

Figure 31. Mudstone medium grey with metallic lustre due to pyrite from Los Cuervos Fm. Drilled with PDC bit & OBM.

Figure 32. Siderite moderate yellow with greenish black mottled due to dark green nodules from Carbonera C8 Fm. Drilled with PDC bit & OBM.

Figure 33. Sandstone dark and medium grey streaks due to quartz & lithic grains and orange yellow stained due to siderite nodules from Los Cuervos Fm. Drilled with PDC bit & OBM.

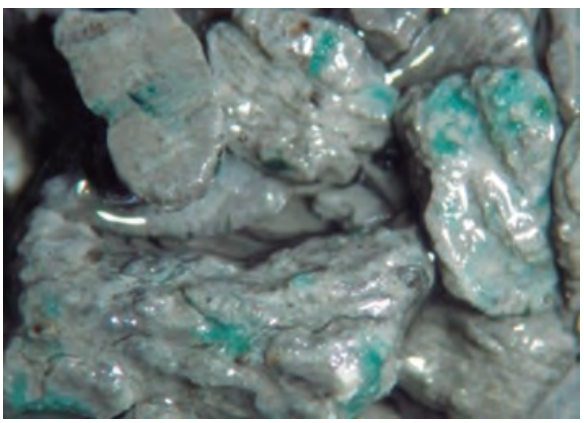

Figure 34. Mudstone medium light grey with green mottled due to glauconite. From Guadalupe Fm. Drilled with PDC bit & WBM.

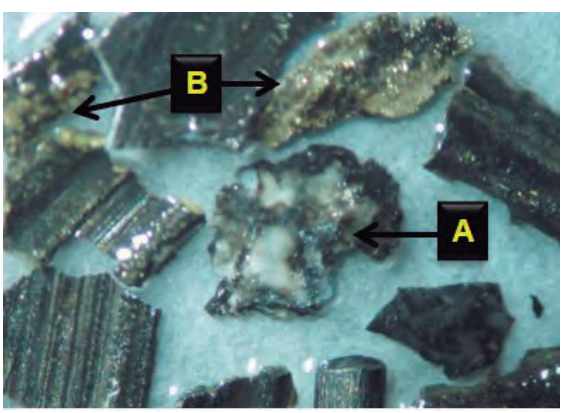

Figure 35. Sandstone metamorphosed bit cuttings with (A) Quartz relicts & (B) Pyrite relicts. From Mirador Fm. Drilled with impregnated bit & OBM.

Bit cuttings surfaces occasionally exhibit cavities because of the detachment of relicts grains (Figure 36).

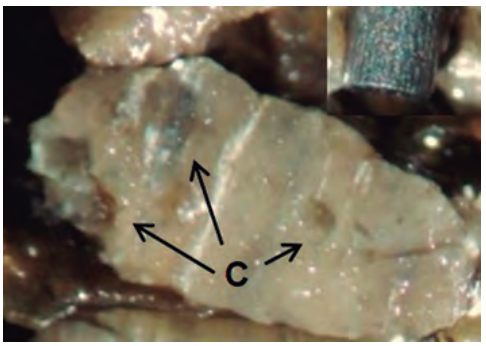

Figure 36. Sandstone greyish yellow, platelet with cavities (C) because of falling of quartz grains. From Mirador Fm. Drilled with PDC bit & OBM.

Primary components and accessory minerals can be recognized by comparing the bit cuttings against unaltered chips (Figures 37, 38, 39 and 40).

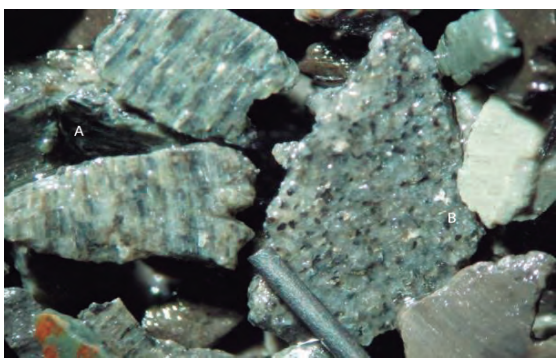

Figure 37. Sandstone sub-lithic light grey. (A) Platelets. (B) Unaltered chip. From Los Cuervos Fm. Drilled with PDC bit & OBM.

Figure 38. Phosphatic sandstone olive brown. (A) Platelet with streaks. (B) Chips from Gacheta Fm. Drilled with PDC bit & OBM.

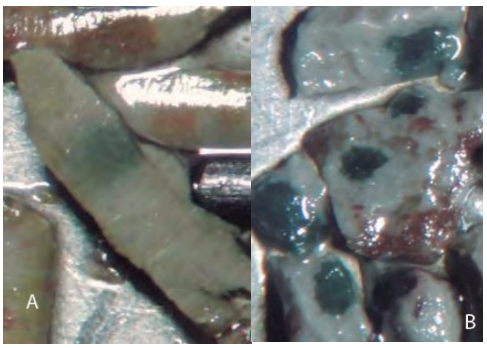

Figure 39. Mudstone medium light grey with green nodules from Los Cuervos Fm. (A) Platelet. (B) Natural texture. Drilled with PDC bit & OBM.

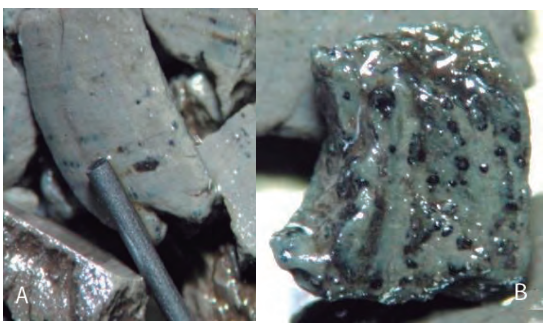

Figure 40. Mudstone medium grey with glauconite from Carbonera C8 Fm. (A) Platelet. (B) Chip. Drilled with PDC bit & OBM.

Sometimes the mineral tiny crystals can preserve their habit and they can be identified with higher magnification (Figure 41).

Figure 41. Mudstone light yellowish brown with siderite nodules (magnification x32) from Carbonera C7 Fm. Drilled with PDC bit & WBM.

ROCK COLOUR DESCRIPTION

Geologists have the routine to determine the colour of the rock by collecting a bit cutting and place it on the rock colour chart, first under visible light and then under the binocular loupe (Santosa, 2012). In most cases the resulting colour does not match with the colour observed on the sample tray under microscope. This is because the bit cutting loses quickly humidity and in addition under natural light there is a change in the light source. Swanson (1981), recommended that colours be observed on wet samples under a magnification per ten and always under same source of light.

Consequently, I recommend that colour should be defined when tray sample is being analysed under stereo microscope and matched with rock colour chart. The recommended light source is daylight lamp with a colour temperature > 3500°K (Figure 41). The reason for this procedure is because in the future when someone uses this information to make a geological correlation, its first look of bit cuttings will be under microscope.

Keep in mind that bit cuttings from well drilled with oil base mud have a darker colour than those drilled with water base mud (Figure 42).

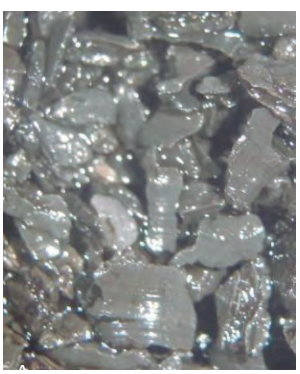

Figure 42. Mudstone (A) Medium grey photograph taken with gooseneck light with a colour temperature >3200 °K. (B) Brownish grey is due to halogen light with a colour temperature <3200 °K. From Carbonera C8 Fm. Drilled with PDC bit & OBM.

Figure 43. Mudstone. (A) Medium light grey (WBM). (B) Greyish black (OBM). From Guadalupe Fm. Drilled with PDC bit.

Additionally, when tray samples are stored in the laboratory to be described or checked long afterwards they have been washed, the colour may be altered. This is particularly true for wells drilled with oil base mud where bit cuttings quickly take an olive grey hue which is easily corrected wetting and agitating the sample.

RECOMMENDATIONS

All bit cutting types and caving observed in the samples trays should be registered and reported. This applies to know the borehole conditions, lithological changes (formational contact or faulting contact), bit condition, etc. It has major relevance during the drilling of deep holes cased with various liner sizes where it was observed a recirculation of bit cuttings or when the hole is drilled with reused mud.

Not all people see the same hues, so it is import to use of rock colour chart to standardize samples description.

If micro-photographs are acquired, a visual scale or written reference should be made. In addition, you should make the appropriate adjusted to white balance according to microscope's source light. Most digital cameras provide pre-sets simulating specific ambient values (e.g., sunny, cloudy, tungsten, etc.).

CONCLUSIONS

New technologies in drill bits make them more aggressive destroying the rock texture making it difficult lithological interpretation and evaluation of the hydrocarbon presence.

Mud additives could affected the samples colour, fluorescence and oil show. Any change in mud properties should be recorded.

Bit cuttings morphology combined with drilling parameters are a tool to determine bit wear.

ACKNOWLEDGMENTS

I want to thank geologists M. Gossart (former employee of TOTAL), A. Rosero (HOCOL) and R. Alvarez y H. Aguirre (former employees of EQUION ENERGIA) for allowing me the use of photographic material presented in this guide and J. C. Alzate (former employee of EQUION ENERGIA) and engineer R. Di Marco (VANGUARDIA LIBERAL) by the reviewing the text.

BIBLIOGRAPHY

Graves, W., (1986), Bit-Generated Rock Textures and Their Effect on Evaluation of Lithology, Porosity, and Shows in Drill-Cutting Samples: The American Association of Petroleum Geologist (AAPG). Volume 7, No. 9 (September 1986), pages 1129 –1135, 11 figures, 1 table. Tulsa, Oklahoma, USA.

Munsell Color, (2009). Rock-Colour Book: Geological Society of America (GSA), 5 Tables, Grand Rapids, Michigan, USA.

Pinto, H. & Peña, L.H., (2013): Huron 2ST3 Well, Geological Report: HOCOL S.A. 101 pages, 2 tables, 23 figures, 362 photographs, 1 annex (Unpublished).

Pinto, H. & Peña, L.H., (2014): Huron 3Z Well, Geological Report: EQUION ENERGIA LIMITED. 80 pages, 2 tables, 13 figures, 262 photographs, 1 annex (Unpublished).

Santosa, A. A., (2012): Cutting Description Guide-Clastic: www.academia.edu. 45 pages, 19 figures, 50 photographs, 20 tables.

Swanson, R. Y., (1981): Sample Examination Manual: The American Association of Petroleum Geologist (AAPG). Methods in Exploration Series. 31 pages, 4 appendixes, 21 charts. Tulsa, Oklahoma, USA.

Wentworth, C. K., (1922). A Scale of Grade and Class Terms for Clastic Sediments: The Journal of Geology

The Journal of Geology Vol. 30, No. 5 (Jul. - Aug., 1922), pages 377-392, 3 figures and 2 tables. Published by The University of Chicago Press.