ICCP

COMMISSION I

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**Radiolytic alteration of organic matter**

**in coal and rocks enriched in radioactive minerals**

2023 ROUND ROBIN EXERCISE

Convenors: **Dr.** **Tatiana Larikova, Dr. Ivana Sýkorová (Czech Republic),**

**Dr. Stavros Kalaitzidis (Greece)**

e-mail: **larikova@irsm.cas.cz**



**Prague, Czech Republic, April 202****3**

1. Introduction

The Radiolytic alterationWorking Group was established during the 73d ICCP Meeting in New Delhi (India) in 2022. The respective information about the established working group was published in the ICCP News Letter No. 84, 2023.

The aims of the Radiolytic alterationWorking Group are:

1) Petrological identification and definition of microscopical textures of radiolytic alteration of organic matter (bitumens, coal macerals, dispersed organic matter) with potential suitability for the ICCP Classification;

2) To determine the basic types of the bright areas around radioactive minerals: halos, bright zones around cracks and veins, and the others. On this base, the system of distinct optical structures will be developed.

3) To determine the range of (critical) uranium concentrations at which the degradation processes of organic matter begin to appear, resulting in increasing light reflectance and formation of zones around radioactive minerals;

### 2. Objective of the 2023 RAWG 1 Round Robin Exercise

The objective of the 2023 Round Robin Exercise is to determine the basic types of the bright areas around radioactive minerals: halos, bright zones around cracks and veins, and the other more complex ones.

During this exercise, participants are asked to identify the basic types of the bright areas around radioactive minerals: halos, bright zones around cracks and veins, and the others, in accordance to the suggested preliminary classification.

Secondly, participants are asked to make comments on the identified forms and on the preliminary classification.

Thirdly, if they would like, participants are asked to add their own examples with radiolytically altered organic matter.

1. **Preliminary classification of the bright areas around radioactive minerals**

Association of uranium with the organic matter have been studied for more than ninety years: in bitumens (Ellsworth, 1928a, b; Parnell, 1993; England et al., 2001), in bituminous coal (Kříbek et al., 2017; Sýkorová et al., 2016; Eskenazy and Velichkov, 2012), in lignites (Havelcová et al. 2014; Rallakis et al., 2019), and in shales (Lecomte et al., 2017; Liu et al., 2020). Uranium minerals occur as inclusions of nanometer to micrometer size, often homogeneously dispersed in the organic matrix. The longer-lasting association of high content of U with bitumen or coal macerals lead to damage of organic matter, especially its morphology, optical properties, and composition.

Petrographic evidences of published radiolytic alteration of organic matter enriched in uranium minerals include formation of:

1. bright simple or complicated circles, ellipses and irregular aureoles ‘halos’, appeared in coal macerals and bitumens around dispersed uranium minerals (Jedwab, 1966; Gentry et al., 1976, Leventhal et al., 1986; Machovič et al., 2021);
2. ii) irregular and asymmetrically embossed bright areas or zones, formed along veins and cracks in organic matter filled with U-bearing minerals (Sýkorová et al., 2016; Havelcová et al., 2022); and also, bright nodular and dendritic textures with irregular morphology and mineralization (Havelcová et al., 2022);
3. iii) bright massive to porous semi-coke/coke formation (Havelcová et al. 2014). During the radiolytic alteration, reflectance values of organic matter increase and fluorescence intensity decreases with increase in U concentration in uraniferous carbonaceous matter (Breger, 1974; Parnell, 1993; Smieja-Król et al., 2009; Zhang et al., 2019; Sýkorová et al., 2016, Machovič et al., 2021, Havelcová et al., 2022).

**Notes**:

Initially, we are going to divide the matter to minerals and organics. Minerals are divided to non-uranium and U-bearing, these, in turn, could be found as single separate grains or dispersed. That may be important in describing the morphology of the radiolytic alteration.

The organic matter will be divided to not-altered and altered radiolytically. Areas and aureoles of radiological alteration may be massive or porous, pale/weak and bright/strong, have sharp or diffused borders. By the morphology we distinguish halos (areoles) around separate U-bearing minerals, sometimes they form groups or colonies. We suppose, it may be important to note if the halos in a colony are interconnected, as interference of halos may occur.

The other, more complex, textures of radiolytic alteration of organic matter besides halos, we describe as having an irregular morphology. These textures may represent as their appearance: massive, rounded, nodular or patchy, but also the possible mechanism of their formation: dendritic, fragmented, flow or being formed along cracks and veins, filled with U-bearing minerals. By the last pattern (complex) we are going to mark the textures, which can’t be described by previous patterns.

In case if the textures of the radiolytic alteration are porous, we would like to note if they can be attributed to semi-coke or coke.

**Examples:**

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| Radiolytically altered areas along the cracks, and pale halos with diffused borders around separate U-minerals in not-altered fossil resin (duxite). | Radiolytically altered rounded aureole (halo) with diffused borders and darker inner rim around separate U-mineral in bitumen. |
| Radiolytically altered bright halos with diffused borders and darker inner rim around separate U-minerals in bituminous coal. | Radiolytically altered bright interconnected halos with diffused borders and darker inner rims around fragmented U-minerals in bitumens. |

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| Radiolytically altered bright interconnected colony of halos with diffused borders around U-bearing minerals in bitumens with dispersed mineralization. | | Radiolytically altered massive irregular areas with diffused borders in ~~in~~ bitumens, filling the fractures, containing U-bearing minerals. | |
| Radiolytically altered patchy interconnected colony of halos with diffused borders and darker inner rims around dispersed U-minerals in bitumens. | | Radiolytically altered complex flow irregular texture with darker inner rims around separate U-bearing minerals. | |
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**Round Robin Exercise**

The 2023 Round Robin Exercise is based on **39** slides with **96** marked areas, containing radiolytically altered organic matter from uraniferous coals and rocks with bitumen. Pictures are taken under reflected non-polarized incident white-light (RL), and/or under UV fluorescence microscopy; all of them with immersion oil, if not indicated -dry-. Some slides also contain notes on the random and mean – average reflectance values of weak and strong alteration; and bulk uranium content.

Participants are asked to determine the form of radiolytic alteration in the rectangle in accordance to the preliminary classification and mark the answer in the attached Excel file (2023\_Round\_Robin\_Exercise\_ RadAltWG.xls).

How to mark answers in the attached Excel file according to the established classification:

1. In case of **Level 1: Organics -Minerals**, please mark **one** of them.
2. In case of **Level 2:** **Uranium content (low, medium, high)**, please mark **one** of them.
3. In case of **Level 3:** M**inerals: Non-Uranium – U-bearing,** please mark **one**.
4. In case of **Level 4:** M**inerals-Uranium-bearing minerals: single grain - dispersed,** please mark **one**.
5. In case of **Level 5: Organic matter: Non-Altered and Altered,** please mark **one** of them.
6. In case of **Level 6:** **Organic matter- Altered - Intensity of radiolytic alteration: pale/weak or bright/strong**, please mark **one** of them.
7. In case of **Level 7:** **Organic matter- Altered - Borders of altered areas (sharp – diffused)**, please mark **one** of them.
8. In case of **Level 8:** **Organic matter- Altered - Character of altered areas (massive – pores/holes)**, please mark **one** of them.
9. In case of **Level 9:** **Organic matter- Altered - Morphology of altered areas: Halo - Irregular**, please mark **one** of them.
10. In case of **Level 10:** **Halos: single – group/colony**, please mark **one** of them.
11. In case of **Level 11:** **Halos in group/colony: separated – interconnected**, please mark **one** of them.
12. In case of **Level 12:** **Darker inner rim in halos; single – group/colony**, please mark **one** of them.
13. In case of **Level 13:** **Organic matter- Altered - Irregular morphology: Massive, Along fractures/veins, Patchy, Rounded; Flow; Dendritic; Nodular; Complex**,please make **one or** **multiple**.
14. In case of **Level 14:** **Semi-coke/Coke**, please mark **one or none** of them.

### Time limit for the 2023 RAWG Round Robin Exercise

It is anticipated for the participants of the RAWG Exercise 2023 to submit the results electronically by the **June 30, 2023** in form of established exercise sheets to Tatiana Larikova ([larikova@irsm.cas.cz](mailto:larikova@irsm.cas.cz)).

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