Chapter 1
Advances in Forensic Geochemistry

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ABSTRACT

This chapter is meant to give the state of the art of forensic geochemistry and recent advances. In terms of forensic organic geochemistry, detecting mature organic matter including polluting hydrocarbons follows an experimental procedure by using recent experimental analytical techniques. However, the interpretation of these results needs an understanding of the geochemical context to make a distinction between the natural and the human made origin of oil. Infrared data coupled with statistical analyses would have an important relevance for the detection of the pollution during the Anthropocene, which is marked an increasing human pollution reaching the level of environmental crimes. In terms of nuclear and isotopic forensic geochemistry, recent studies provided that nuclear forensics considers the fact that some measurable parameters or signatures are distinctive.

1. INTRODUCTION

Forensic geochemistry is study of organic (de Oliveira et al., 2020; Poulson and Drever, 2020) and inorganic elements (John et al., 2021) occurring when environmental crimes related to pollution of soil, surface and/or deep water, atmosphere and rocks had taken place. The geochemical analysis of traces in the forensic field is able to determine the origin and type of contaminants and the processes of interaction between chemical contaminants and contaminated (Whyte et al., 2021). Geochemical surveys can also provide important support for the investigation of events such as murder,

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rape, theft (Dawson et al., 2021). The geochemical analyzes mainly applied in the forensic field are the analysis of trace elements (Sutliff-Johansson, 2021) and the analysis of radioactive and stable isotopes (Ubelaker and Francescutti, 2020; Migeon et al., 2020). The isotopic composition of geological material can provide relevant information to delineate crime trends. Moreover, thanks to this type of analysis, it is possible to date the material and sometimes the processes suffered from the same material (Kristo, 2020). This chapter is meant to review recent advances in forensic geochemistry dealing with organic pollutants as well as inorganic contaminants such as trace elements, radioactive and stable isotopes.

2. FORENSIC ORGANIC GEOCHEMISTRY

Biomarkers are one of the most important hydrocarbon classes in petroleum (Malmborg et al., 2020). They are one of the most resistant groups of hydrocarbons to degradation in the environment (Thienpont et al., 2021). Using gas chromatography/ mass spectrometry (GC/MS) we can detect biomarkers in small quantities (ppm and sub ppm) in the presence of a wide variety of other petroleum hydrocarbon types. Biomarkers are one of the most degradation resistant groups of hydrocarbons in the environment. They have formed under a variety of conditions and geological ages resulting in several biomarker fingerprints. Chemical analysis of biomarkers gives very important information to environmental legal investigations from the point of view of determining the source of spilled oil, differentiating and correlating oils and monitoring the degradation process and eroding condition of oils under a wide variety of conditions. Biomarkers have for many years been widely used in petroleum exploration and reservoir geochemistry to obtain information of value to geochemists such as the thermal maturity of the oil, the type of source material, the depositional environment of the source rock, the approximate geological age of the source rock and the degree of biodegradation of the oil (Zhou et al., 2021). This chapter provided a brief overview and discussion of biomarker chemistry, biomarker characterization and quantification, biomarker distributions, eroding effects on biomarker composition.

2.1. Methods of Forensic Organic Geochemistry

Organic Matter Extraction and Analysis

The use of biomarker data is a long-standing tool in petroleum system analysis, but it is also widely used in forensic geochemistry to identify oil spills (Nuzzo and Gehlen, 2021). Biomarkers are complex molecular fossils derived from once-