Photoluminescence and Microanalysis of Organic Macerals in the Kimmeridge Clay Formation, Offshore United Kingdom

H.A. Lowers[1], P.C. Hackley[2], N.S. Fishman[3]

[1]U.S. Geological Survey, MS973, Denver, Colorado 80225 USA
[2]U.S. Geological Survey, MS956, Reston, Virginia 20192 USA
[3]Hess Corporation, Houston, Texas 77010 USA

The Upper Jurassic Kimmeridge Clay Formation which consists of organic-rich shales is the principal source of petroleum and gas produced from the North Sea area [1]. Porosity of the inorganic and organic components of the rock with increasing thermal maturity has been described [2]. This study builds on previous work to characterize chemical changes of macerals identified using organic petrography and photoluminescence spectroscopy, and determines the chemical composition of the identified macerals using electron beam based microanalysis.

Ion milled rock sections and polished thin sections representing different thermal maturity levels were studied. Imaging for maceral identification was carried out with a Zeiss AxioImager polarizing microscope equipped with an MRc digital camera and tungsten halogen and fluorescence illumination from EXFO. Zeiss AxioVision software for capture and analysis was used to image the same fields in 5 different types of illumination: white, blue, and ultraviolet incident light and plane-polarized and cross-polarized transmitted light.

For low maturity samples, areas that were examined via optical microscopy were relocated for quantitative elemental analyses of individual organic macerals (fig 1). The analyses were acquired with a JEOL 8900 electron microprobe operated at 10kv, 20 nA (cup), and a focused beam. The following elements were analyzed: S, Fe, V, Ni, Mo, U, Zn, Cr, and Co. Carbon was added as the difference from one hundred percent. Metal standards were used with the exception of Fe and S for which pyrite (FeS2) was used and U for which a uranium oxide was used. Qualitative chemical observations of the higher maturity samples were made with SEM/EDS analysis.

Identified organic macerals of marine origin include *Tasmanites*, bituminite, and lamalginite. Organic macerals of terrestrial origin include vitrinite, fusinite, and semifusinite. Macerals of secondary origin, associated with hydrocarbon generation, include micrinite and solid bitumen. Of all maceral types analyzed, sulfur was consistently the highest concentration element measured and it tended to be present in higher concentrations in the marine based macerals (5-10 elemental wt.%) than the terrestrial based macerals (1-6 elemental wt.%). Most other elements were below detection with the exception of Fe and occasionally V. In the higher maturity samples, the amount of sulfur was greatly reduced in maceral types of marine origin compared to low maturity samples.

References:

[1] Cornford, C. (2009) Source Rocks and Hydrocarbons of the North Sea, in Petroleum Geology of the North Sea: Basic Concepts and Recent Advances, Fourth Edition (ed K. W. Glennie), Blackwell Science Ltd, Oxford, UK. doi: 10.1002/9781444313413.ch11.

[2] Fishman et al., AAPG Annual meeting, abstract # 1234997 (2012)

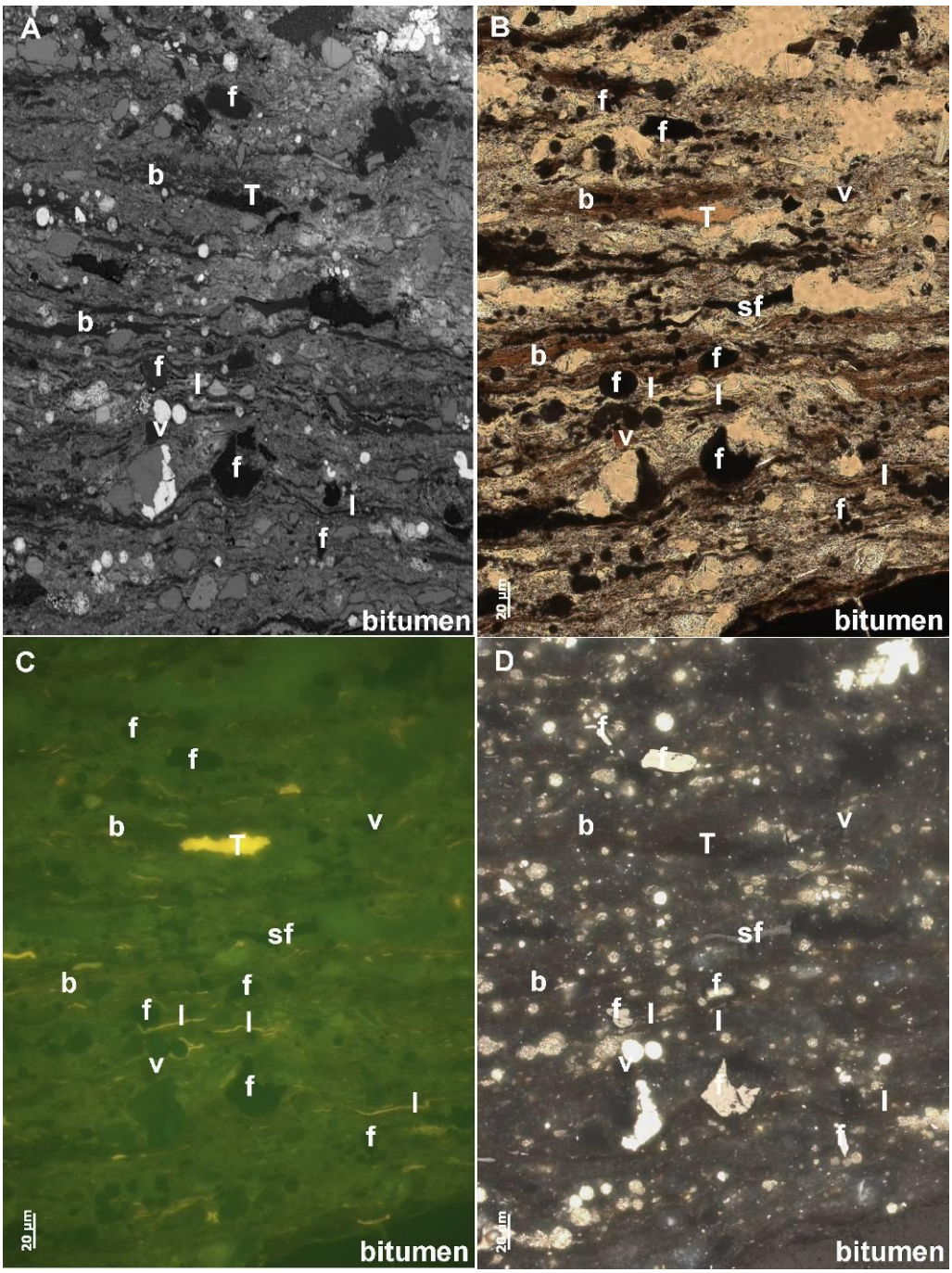

Fig.1. A field of view of a low maturity Kimmeridge Clay Formation sample with a detrital grain of bitumen visible in the bottom of the field. A. backscattered electron image, B. transmitted light image, C. blue incident light under oil immersion, D. white incident light under oil immersion. The letters refer to the identified maceral type: f-fusinite, sf-semifusinite, v-vitrinite, T-*Tasmanities*, b-bituminite, l-lamalginite.