

## **The crystal structure, origin, and formation of idrialite (C<sub>22</sub>H<sub>14</sub>): Inferences from the microbeam and bulk analyses**

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### **ABSTRACT**

Idrialite from Skaggs Springs, Sonoma County, California, was studied by microbeam and bulk analyses; the former include micro X-ray diffraction ( $\mu$ -XRD), electron microprobe (EMP), and micro Fourier transform infrared ( $\mu$ -FTIR) spectroscopic analyses, and the latter include powder XRD analysis, thermogravimetry-differential thermal analysis (TG-DTA), and carbon isotope analysis. Careful observation under a stereo-microscope clearly disclosed that the examined sample is composed of yellow and brown parts. The yellow parts were identified as idrialite with high crystallinity, whereas the brown ones were confirmed as amorphous matter by  $\mu$ -XRD. Furthermore, the  $\mu$ -FTIR spectra revealed that the yellow and brown parts contain hydrophobic and hydrophilic compounds, respectively. EMP analysis showed no chemical zoning and homogeneous distribution of S-bearing molecules in the yellow parts. TG-DTA disclosed that the present idrialite of the yellow part left no residue on heating up to 740 °C; this thermal behavior is similar to that of the other natural organic matter in liquid states such as petroleum and crude oil. The carbon isotopic composition was analyzed using an elemental-analyzer isotopic-ratio mass spectrometer (EA/IRMS). The  $\delta^{13}\text{C}$  value of the idrialite is  $-24.429 \pm 0.090\%$  (vs. V-PDB), which is akin to carbon isotopic compositions of the typical higher-plant triterpenoids contained in sedimentary organic matter.

Both the yellow part (idrialite) and brown part (amorphous organic matter) occur on the coexisting minerals (opalline silica, metacinnabar, and siderite); the textural relationship indicates that the organic matter precipitated after crystallization of the associated minerals. Thus, it is suggested that the organic molecules were migrated by hydrothermal fluids and then separated into hydrophobic (idrialite) and hydrophilic (amorphous organic matter) molecules during the cooling process. Following the separation, idrialite was crystallized and then the amorphous organic matter was precipitated at the final stage of the hydrothermal activity.

**Keywords:** Idrialite, picene, crystal structure, carbon isotopic composition, polycyclic aromatic hydrocarbons