

A Study of Synchrotron-based Infrared Microspectroscopy: Characterization of Organic Matter Extracted from the Sediments and Groundwater in Southwestern Taiwan Study

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Alluvial aquifers of Taiwan were severely affected by arsenic. As a result, thousands of people in Taiwan are at risk of different kinds of diseases. In late 1950 to early 1960, the resident of southwestern Taiwan was alarmed to suffer from blackfoot disease and its associated diseases (e.g., skin diseases and cancers). Sediments and groundwater from Chianan plain were collected for humic substances and toxic trace element analyses. We analyzed groundwater as well as sediment for determining functional groups of humic substances or other organic compounds using Fourier-transform infrared microspectroscopy (FT-IR microspectroscopy) at NSRRC on 14A1 beam line. We extracted humic substances powder from sediments using acid alkaline method. FTIR spectra show the strong evidence of humic substances found in sediments in southwestern Taiwan. FT-IR spectra also suggest that the functional groups such as COOH, C-O, C=C (aromatic ring) (Tables 1) were present in humic substances of southwestern Taiwan, which acts as chelating agents, bounded with other trace elements in sediments. Moreover, humic substance plays a role for binding toxic elements (As, Pb, Al) with sediments, which subsequently changes the redox state of arsenic or other trace elements and releases toxic species (As^{+3}) in groundwater, which may be responsible for blackfoot disease (BFD) in southwestern Taiwan.

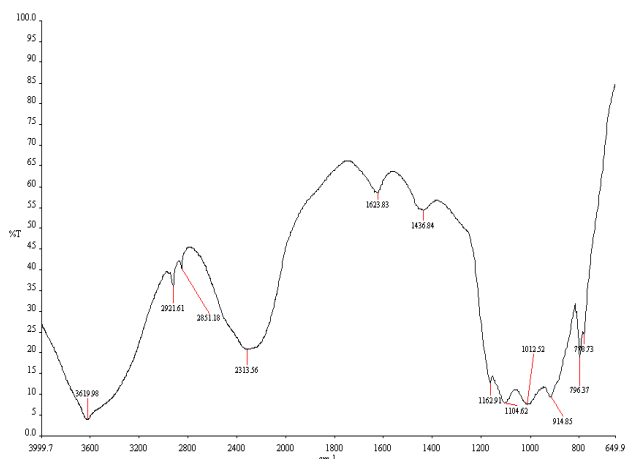


Fig. 1: IR spectra of humic acid from sediments of Chianan plain.

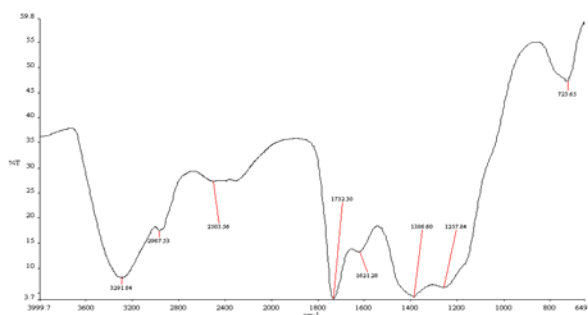


Fig. 2: IR spectra of humic acid from groundwater

Classification	Group	Bond	Range
Alkenes-IR	CCCH=CHCC	CC	1680-1620
Alchoholes	Ph-OH	OH	3250-3200
Amides(I)	(-CO-NH-C)	C=O	1680-1630
Amides(II)	(-CO-NH-C)	CNH	1570-1515
Amides(III)	(-CO-NH-C)	CNH	1305-1200
Amines-IR	Ph-NH-R	C-N	1315-1250
Ketones	(-CO-C=C-OH)	C=O	1640-1590
Ethers-IR	3-Ring-ETH	C-O-C	1280-1230
Aromatic-IR	o-Disubst	Ring	1590-1575
Carbo-acid-IR	C-C-COOH	C=O	1725-1700
Esters	Ph-CO-O-R	C-O	1310-1250

Table 1: Functional groups of humic substances of core sediments and groundwater from Chianan plain were determined by FT-IR microspectroscopy

Humic acid extracted from sediment and groundwater of Chianan plain is characterized by carboxylic, esters and aromatic ring peaks at 1725 cm^{-1} , 1320 cm^{-1} and 1600 cm^{-1} . This functional group of humic acid may be combined with arsenic via cation bridging produce organometallic compound which may cause blackfoot disease in southwestern part of Taiwan.