

Chemical basis of microbe-carbonate interactions

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The interplay of microbes and carbonate minerals at near-surface conditions is extensive and plays a critical role in regulating water chemistry and atmospheric composition. It is widely accepted that microbe-carbonate interactions are biologically induced processes; however the participating chemical agents are largely unidentified. Here we study the interactions of selected microorganisms and carbonate minerals to evaluate the chemistry involved. We first examined the effect of a soil bacterium on calcite crystallization and found that the mineralization process was affected by the culture composition. Results show that the crystal size, quantity, as well as morphology differ depending upon whether nitrogen is present in the cultural media. Fewer crystals are seen in the absence of N, but the grains tend to be large and morphologically less affected. Further analyses indicate that N affects the extent of capsule formation and the activity of metabolic carbonic anhydrase (CA). Under N stress conditions, the bacteria secrete large amount of extracellular polymeric substances (EPS) and consequently grow a thick capsule; however, CA produced by the metabolic process has a low activity. These observations suggest that both EPS and CA may be actively involved in the mineralization processes. Additional carbonate dissolution experiments reveal that Ca release does not respond to microbially induced pH change in the experimental solutions, but show a strong correlation with the activity of carbonic anhydrase from different microorganisms, implying that metabolic products, not acidity, may be the governing factor for microbe-calcite interaction. These results suggest that microbial mineralization and dissolution are multifaceted processes that may include substrate effect, enzymatic catalysis, as well as acid and ligand promoted surface and solution chemistry.

Release of toxic elements from air-exposed coal of Guizhou, China

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Long-term air-exposure of coal presents potential environmental and human health hazards [1, 2]. Confined by limited research approaches, the chemical mechanisms of the release of toxic elements in coal remains largely unknown. Our research focuses on outcrop coal which prevails in Guizhou province of China and is often collected for local residential use in remote area with a long history, which is believed to be a potential source for some serious endemic diseases [2-4].

Outcrop coal samples from Guizhou were analyzed by means of time-of-flight secondary ion mass spectrometry (TOF-SIMS) with high mass and spatial resolutions. In previous study, evidence of elemental sulfur (S₈) in organic maceral of high sulfur coal from Guizhou were presented [5].

Hundreds of ion images obtained from our study with high mass spectra explicitly explain the spatial segregation and speciation relationships between elements and organic and inorganic molecular species (see Fig. 1). This information enhances previous studies which note the presence of species. The activations and releases of both siderophile and lithophile elements are largely attributed to natural oxidation of sulfur in coal. Also, two states of clay were observed in organic maceral and inorganic phases.

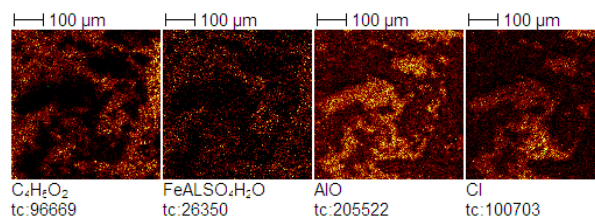


Figure 1: Negative ion images to illustrate correlation of distribution of organic and inorganic specie in air-exposed coal from Puding area of Guizhou.

In addition, our results show direct evidence that fluorine (F) does exist in the syngenetic clay of the coal rather than organic macerals.

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- [1] Finkelman *et al.* (2004) *Int. J Coal Geol.* **59**, 19–24.
 [2] Finkelman *et al.* (2002) *Int. J Coal Geol.* **50**, 425– 443.
 [3] Zheng *et al.* (2006) *Goldschmidt Conf. Abs.* A744. [4] Dai *et al.* (2007) *Appl. Geochem.* **22**, 1017–1024. [5] Liang (1999) *Chinese Sci. Bull.* **44**, 1242–1245.