Sulfuric Acid Dissolution on Karst Landforms

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Abstract: In geological textbooks and numerous karst research papers and monographs, when discussing the chemical mechanism on karst processes, it usually refers to carbonic acid dissolution, that is carbon dioxide dissolves in water to form carbonic acid, which reacts with soluble rocks to form karst landforms.In recent years, a fair amount of studies has been carried out on sulfuric acid dissolution, but they mainly focus on hypogenic karst caves. With the intensive study of deep-buried hydrocarbon reservoirs, more and more scholars proposed TSR (thermochemical sulfate reduction) for the dissolution of deep burial carbonate reservoirs. It is found that, hydrogen sulfide formed in the process of TSR dissolved in the water, and the hydrosulphuric acid was generated largely, the strong corrosiveness of hydrosulphuric acid accelerate the dissolution of carbonate rocks in the reservoirs. The results provide a strong proof for the sulfuric acid dissolution of hypogenic carbonate karst. However, reports about sulfuric acid dissolution on superficial karst is rare. So, what surface karst landforms are mainly caused by sulfuric acid dissolution? What is the source of sulfuric acid? What is the chemical reaction process of sulfuric acid dissolution? In view of the above issues, the authors review references about Carlsbad Cave in New Mexico, the United States and Shuanghe Cave in Guizhou, China, where the sulfuric acid dissolution is the major aspect of chemical dissolution, and found that the origin of sulfuric acid are hydrogen sulfide rising from deep within the earth's surface, or the oxidation of ferric sulfide such as pyrite. And the chemical reaction processes are as follows:

$$CaSO_4+\text{Hydrocarbons/Reducing Bacteria } (CH_2O) \rightarrow CaCO_3+H_2S+H_2O$$

$$H_2S+2O_2 \rightarrow H_2SO_4$$

$$Ca{\cdot}Mg(CO_3)_2+H_2SO_4 \rightarrow Ca^{2+}+Mg^{2+}+SO^{2-}{}_4+2HCO^-{}_3$$

$$CaCO_3+H_2SO_4+2H_2O \rightarrow CaSO_4{\cdot}2H_2O+H^+ +HCO^-{}_3$$

Or:

$$2FeS_2+7O_2+2H_2O \rightarrow 4H_2SO_4+2Fe^{2+}$$

$$CaCO_3+H_2SO_4+2H_2O \rightarrow CaSO_4{\cdot}2H_2O+H^+ +HCO^-{}_3$$

Key words: karst processes, sulfuric acid dissolution, Carlsbad Cave, Shuanghe Cave

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