Study of The Structural Characteristics and Genesis of Thermokarst Lake in The Muli Area, Qinghai Using Electromagnetic Detection Data

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Abstracts: The Muli area in Qinghai is the only region that has drilled gas hydrate at middle-low latitudes in continent. Since 2008, the China Geological Survey and Shenhua Group have drilled more than 30 wells in the Muli area. Only one-third of the wells have obtained gas hydrate, and gas hydrate exploration in continent has entered a bottleneck period. With in-depth study of regional structure, hydrocarbon source, accumulation model, etc., combined with the data of occurrence characteristics of gas hydrate in the cryosphere in the Qinghai-Tibet Plateau and the South China Sea, the author believes that the gas hydrate in the Muli area is closely related to the Quaternary glaciation, which is the development of periglacial landform. The gas hydrate is undergoing a cycle of “decomposition-formation-decomposition” with the evolution of glaciation. During the interglacial period, the zone temperature increases, and the overburden pressure decreases, so gas hydrate is decomposed and migrates upward to the shallow part and accumulates, resulting in explosion or episodic dissipation under certain pressure conditions. During the process, a series of dissipation systems consisting of fractures, fissures, etc., will be formed in shallow layers, and gas chimneys and other structures may be developed in the lower part, leaving a concave landform formed by explosion or eruption of gas hydrate on the surface. This effect is pervasively developed on the sea floor, forming pockmarks, gas chimneys, mud volcanoes and other structures. In continent, traces like thermokarst lakes may be left. Therefore, prospecting structures and geophysical responses associated with gas dispersion provides a new perspective for carrying out geophysical work in shallow parts and gas hydrate exploration in continent. According to the evaluation of shape-development degree of pockmarks in the sea, we chose Anjin Lake as the research object. After detection of low-frequency ground penetrating radar, obvious chimney-shaped reflection patterns occur below the banks of the lake. Instantaneous frequency spectrum analysis was used for the original data, and it is found that instantaneous frequency of high-frequency energy spectrum occurs below the middle region of


Fig. 1. Distribution characteristics and on-site topographic map of some hot ponds in Muli area.
(a) Plateau hot karst lake group around Muli Coal Mine; (b) The small-scale hot karst pond lake is linear and flaky in the Muli area; (c) Topography of Anjin Lake.

Fig. 2. Ground Penetrating Radar Detection Results for Anjin Lake.
(a) The underground structure on the banks of both sides of the lake shows a chimney-like shape; (b) The underground space of the lake heart exhibits the instantaneous frequency of the high-frequency energy spectrum.

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the lake, reflecting the locally inconspicuous unconformity characteristics of faults. Using the audio frequency magnetotelluric sounding technology, the thickness of permafrost in Anjin Lake and its surrounding areas and the distribution of faults in the area were studied and characterized. It is believed that the thickness of permafrost in the area of Anjin Lake is 60-70 m, thinner than surrounding areas. The distribution of high-resistance anomalies and low-resistance anomalies and dip reflect the southward thrust characteristics of faults. The development scale of faults increases from west to east, and the penetration depth increases. The strike of the structures is mainly NW-SE. Using electromagnetic detection data, the underground chimney shape and the discontinuous fault characteristics in thermokarst lakes in the Muli area were investigated and studied. On the one hand, it can explain the leakage and dissipation of gas in some areas; on the other hand, it can also illustrate that tectonic activity in some areas is conducive to the re-aggregation and accumulation of deep gas in the areas, which has become an important reference indicator for guiding hydrocarbon resource exploration.

Key words: ground penetrating radar, AMT, plateau hot karst lake, gas escape system

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References


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