

# Distribution characteristics of land hydrate and evaluation of the resource

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**Abstract.** with the development of society, the traditional energy is becoming more and more scarce. The emergence of natural gas has attracted worldwide attention. It is a new clean energy that may replace traditional energy in the future. In the permafrost of Qiangtang basin, the audio magnetotelluric data processing and interpretation for the investigation of natural gas hydrate were carried out. Based on the interpretation and processing, combined with the geological and two-dimensional seismic reflection and geophysical data in the study area, we made a comprehensive research and analysis. The geophysical and hydrocarbon anomalies related to gas hydrates are obtained in the study area. Through the comprehensive analysis of the audio magnetotelluric data and seismic data, we have obtained the data of the electrical and fracture structures in the study area. This provides a scientific basis for the detection of natural gas hydrates in permafrost regions of Tibet plateau, Qinghai, and confirms the reliability of applying geophysical methods to explore natural gas hydrates.

## 1. Introduction

Natural gas hydrate is an ice like solid material formed by crystallization of gas (methane, ethane, carbon dioxide, etc.) and water under high pressure and low temperature (pressure is usually above 10MPa, and the temperature is about 0-10 degrees centigrade). It mainly occurs in the plateau permafrost region, the sedimentary strata of the seabed and the bottom sediments of the deep-water lakes [1-5]. Natural gas hydrate has many advantages, such as shallow buried, wide distribution, high energy utilization and simple reservoir forming conditions. It is a new clean energy instead of coal, oil and natural gas in twenty-first Century [ 6-7], it is also a new energy with huge reserves and undeveloped energy. In 2008, the sample of gas hydrate drilling by the geological survey of the China Geological Survey in the Muli area of Qinghai province was a breakthrough in the exploration of natural gas hydrates in China. Due to the limitation of natural geography and climate conditions, exploration work is mainly concentrated in permafrost regions along the Tibet railway in Qinghai, and



the work in the hinterland is less. Fortunately, has achieved breakthrough point on the natural gas hydrate in permafrost area of Qinghai Tibet Plateau vast, accumulated a lot of valuable research experience; at present, the urgent need to deepen and expand the geological prospecting work, continue to carry out the investigation in a large permafrost zone of gas hydrate. Compared with the Tibet Qiangtang Basin and Qilian mountain in the area, the annual average temperature is lower, the frozen layer thicker and relatively low temperature gradient and good gas into oil, natural gas Chinese is the most favorable area and water [8-9] investigation and mineralization. Therefore, geophysical and geophysical prospecting in the area has obtained geophysical anomalies and hydrocarbon anomalies in the study area, thus providing a basis for further exploration of natural gas hydrate.

## 2. Regional structural features

The study area is located in the Qiangtang basin of the Qinghai Tibet Plateau, and the Qinghai Tibet Plateau is located in the east part of the Tethys tectonic domain. Geophysical data confirm that there is obvious inhomogeneity on the transverse direction in the Qiangtang basin. The North-South zoning shows the basic pattern of strip intersections. The surface shows multiple micro continental blocks separated by the suture zone. The tectonic framework of the Qinghai Xizang Plateau in Qinghai is composed of five suture zones and five block intervals [10-14]. Five sutures formed from north to South and North Qilian respectively West Kunlun Altun suture zone, the southern edge of the Kunlun suture zone, the Hoh Xil Jinsha River suture zone, the Bangong Lake Nu River suture zone and the Yarlung Zangbo Suture zone. Five blocks from the north to the south are Kunlun plots, Bayanhar block and Qiangtang block, Lhasa block and Himalaya block.

The study area is located in the middle of Qiangtang Basin and lake County of Tibet autonomous region, with an average elevation of 4960m. The main formation of Permian Lugu was three in the group of Triassic tumengela group, Middle Jurassic Xiali formation and Upper Jurassic Suowa group, Eocene Laske group, Oligocene group and Suonahu in support of Pleistocene and Holocene strata.

## 3. Data processing

Data processing mainly includes "Edit smoothing", "polarization pattern recognition", "measurement point processing", "static correction" and "two-dimensional filtering", "terrain correction", "one-dimensional, two-dimensional inversion" and so on. Data inversion methods mainly include: BOSTICK inversion, two-dimensional optimization, nonlinear conjugate gradient (NLCG) inversion, two-dimensional OCCAM inversion and two-dimensional fast relaxation (RRI) inversion. For a specific area, there are some differences of different inversion methods; usually inversion in the study area which is abundant geological data segment measured using four kinds of methods to determine the correctness of the inversion method and parameters through real-time monitoring module, the inversion results with geology, drilling and other geophysical data comparison, determine the most the suitable inversion method of the study area.

## 4. Interpretations and data analysis

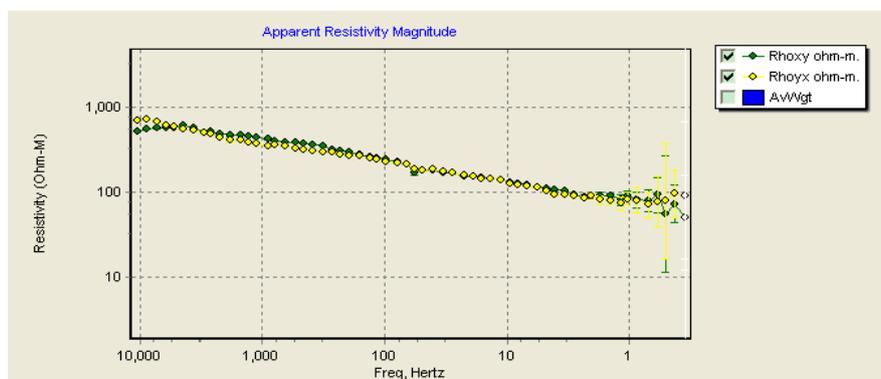
### 4.1. audio magnetotelluric interpretation basis.

Based on the actual geological conditions of the study area and the two-dimensional resistivity profile of the inversion profile, the criteria of stratigraphic, structural and low resistivity abnormal bodies are determined, and the range of low resistivity abnormal bodies is delineated according to the electrical characteristics of different rock bodies. Local rock broken, weak, or water containing rock in electric sounding curves for local relative concave, flat or steep phase curve, resistivity section diagram shows that the closed circle as lump or flake low resistivity; fracture zone and zone of influence on the curve is horizontal, not continuous mutation and the resistivity profile showed multiple banded form or Beaded low resistivity, such as linear gradients at the corresponding maximum fracture zone edge; lithologic contact zone in the curve of transverse mutation in resistivity section on the performance of electromagnetic sounding curve, the original section, inversion section and the geological data analysis

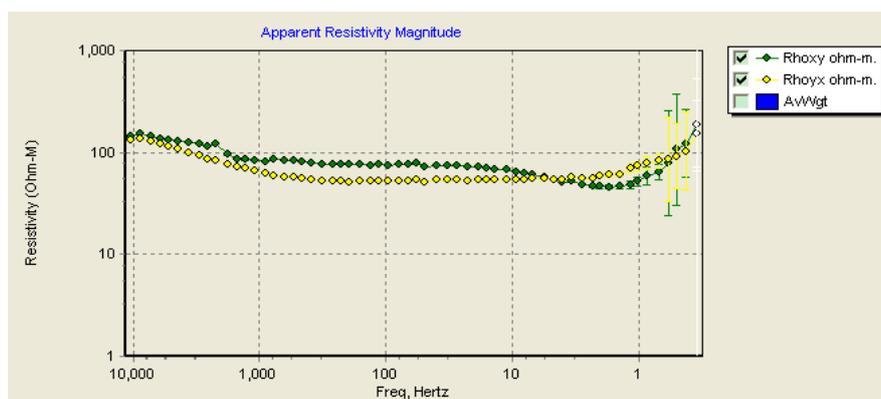
of gradient zone on both sides of the resistivity value, according to the resistivity contour lines in the background values of the size, shape, low resistivity and low resistivity value and background value of the difference, and The electrical structure and geological structure of the underground medium are judged and interpreted in accordance with the stratigraphic lithology corresponding to the actual location.

#### 4.2. Interpretation and analysis of results

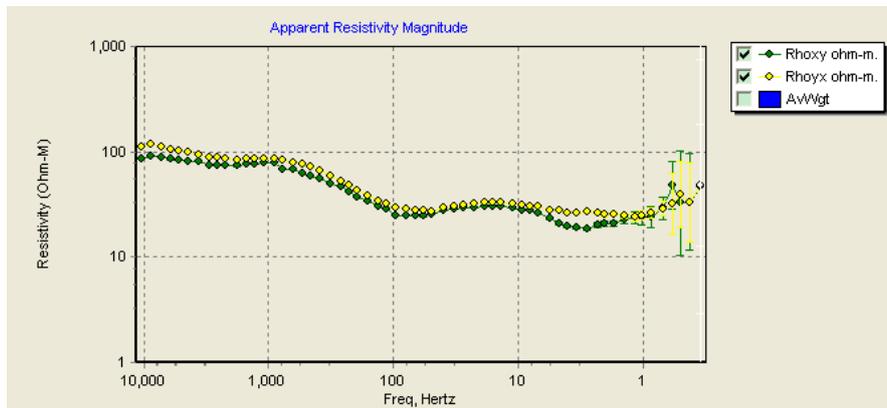
4.2.1. *analysis of the curve type of measuring point.* The curve types in the area of audio magnetotelluric sounding are mainly D type, H type, QH type (see figure 1~3), one of the first most of the performance of high resistivity, deduce that because the shallow strata broken and mostly permafrost area caused by the middle due to the presence of sandstone, mudstone and marl and low resistance of rock body is low resistance tail support features, because the basement lithology or rock integrity presents horizontal or upward trend.



**Figure 1.** D type original curve diagram (K350560)



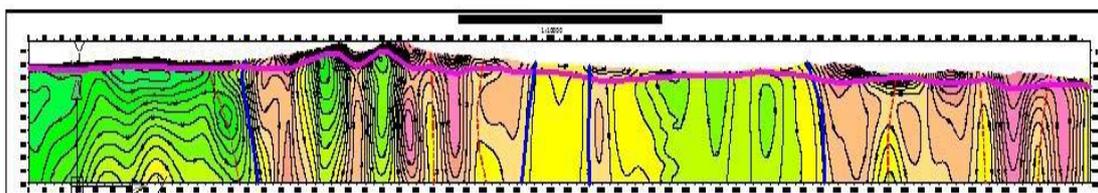
**Figure 2.** H primitive curve diagram (W452820)



**Figure 3.** QH type original curve diagram (K351220)

Combined with the analysis of the results of the audio frequency magnetotelluric sounding, the apparent resistivity of rock area mainly concentrated in the 10~1000 - m, the apparent resistivity is low resistance characteristics in less than 80 m, the apparent resistivity values between 80~200 - M is in high resistivity; apparent resistivity values between 200~1000 - Omega m showed high resistance characteristics. According to the existing geological data of this area, we conclude that the low resistance region is mainly caused by mudstone, marl and shale, siltstone or broken rock, local apparent resistivity is less than 10-ohm m inference for coal (layer) line or carbonaceous rocks caused by; in high resistance region, mainly caused by sandstone and conglomerate etc.; the high resistance region is mainly caused by the tight sandstone, limestone, basalt, etc.

**4.2.2. interpretation of line section results.** That according to the previous results, the natural gas hydrate reservoir in the area, the main reservoir lithology with mudstone and siltstone, shale and fine sandstone, physical properties of these rocks is mainly reflected in the low areas, but this kind of dense rock debris, its permeability is very poor, and did not touch the penetrating ability it was decided in the area dominated by fissure type natural gas hydrate, pore type of natural gas hydrate. Because the fracture system can not only provide channels for upward migration of hydrocarbon gas, but also the main reservoir space for the formation of natural gas hydrates. The interpretation of structural fractures by this geophysical exploration will provide a basis for indirectly finding natural gas hydrates. The following results are described (Figure 4) the analytical inference results of the audio magnetotelluric sounding section of this work are as follows:



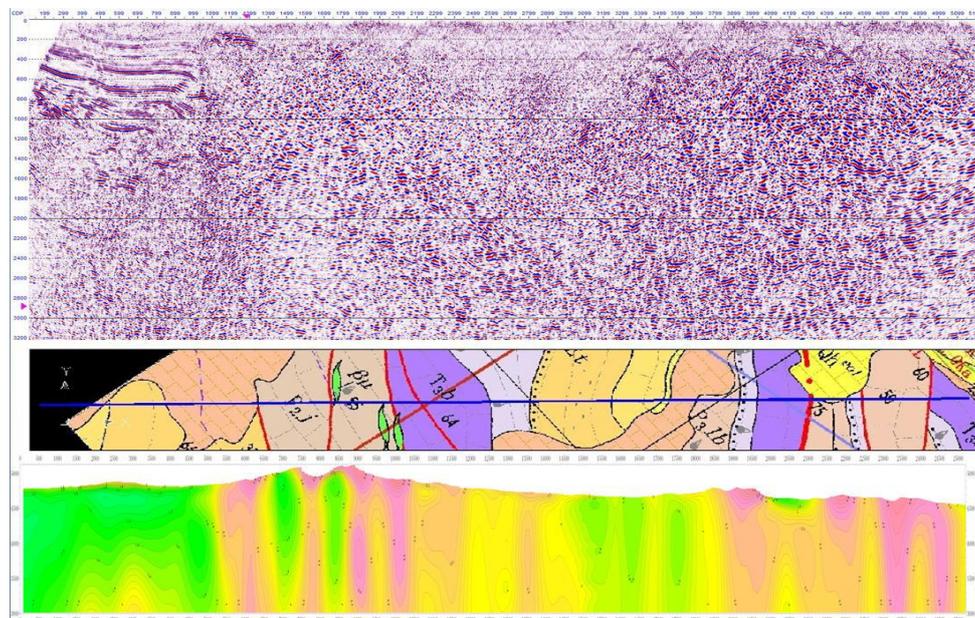
**Figure 4.** interpretation of QNK1 line audio magnetotelluric sounding section results

The line number 0~5200 segments of the overall resistivity value is low, the layered structure was inferred for the Quaternary sedimentary surface, overlying mudstone, marl and silty sandstone low resistivity lithology. The lateral variation of resistivity near 5200 is very large, and it is inferred that it is the boundary of lithology. The 5200~12000 stage resistivity is relatively high. There are all stripes and low resistivity bodies. The resistivity of the surrounding rocks is relatively high at 9500 and 10800 two, and it is concluded that the two fault zones are fault zones. Near 7000 and 8400, the low

resistivity anomaly is from the surface to the deep part. According to the abnormal morphology and the understanding of the topography and surface grounding conditions, it is considered that the two anomalies are not caused by underground geological bodies or structures. The 12000~13300 section is uniform in resistivity, and the section should be the same lithology, and the lithologic boundary between 12000 and 13300 places is deduced. The resistivity of the 13300~18400 section is slightly lower than that in the forepart, and the change is not significant. It is inferred that the section is the same formation. The 18400~25200 segment resistivity is high, and there are 20600, 22500, 24300 three low resistivity anomaly zones, which are deduced to be fault fracture zones. The difference between the resistivity values before and after 22500 is great, and the different lithology is deduced before and after the inference.

## 5. comprehensive research analysis and evaluation

### 5.1. Comprehensive analysis of geophysical data

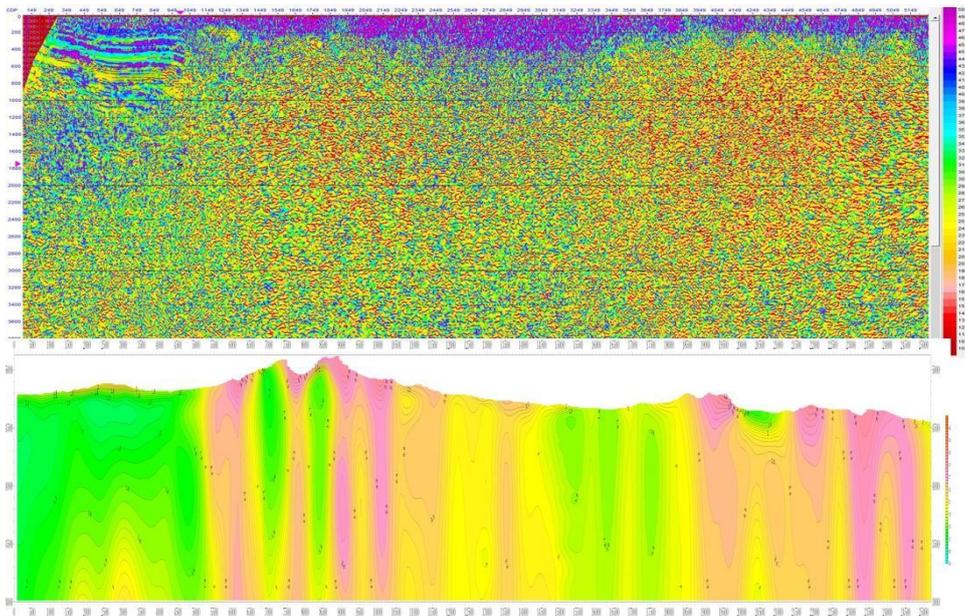


**Figure 5.** contrast section of w113-01 line with QNK1 line and geological map

With the use of seismic line overlap convenience, we will magnetotelluric survey line and seismic line joint interpretation analysis, through comparative analysis of the amplitude, found very consistent characteristics and seismic characteristics of magnetotelluric, figure 5 reflects the comparative position of the same magnetotelluric survey line and seismic amplitude and geological map, see the only, the geological map of the fracture and seismic and resistivity profiles agree well with seismic energy changes in the amount of change in the different words and deeds are in good agreement with the change of the resistivity profile.

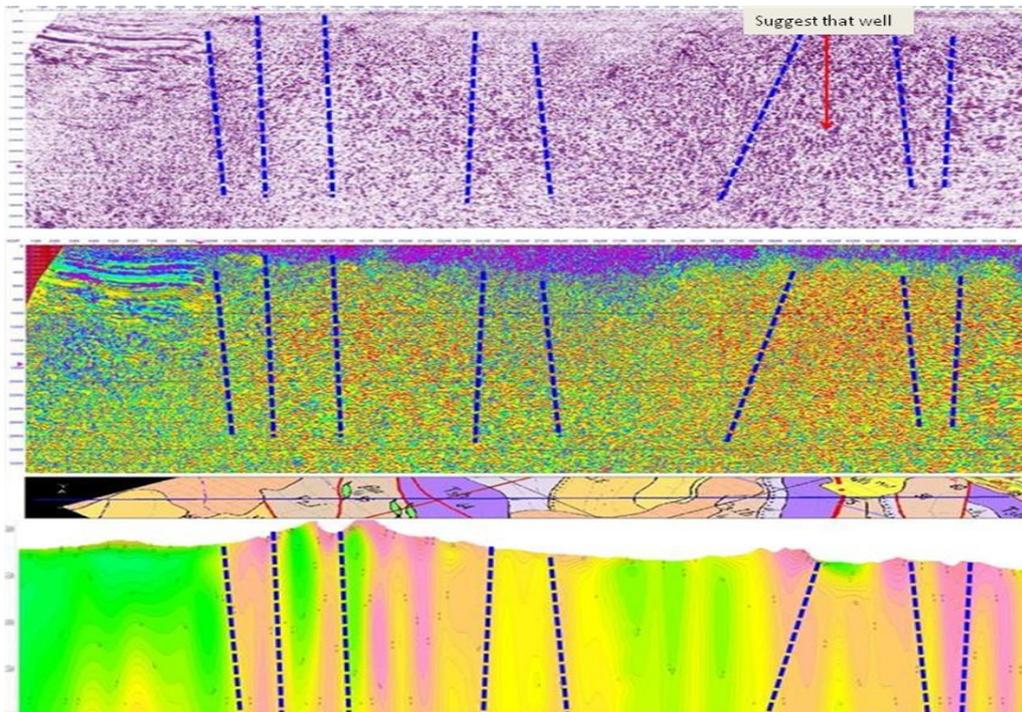
### 5.2. comprehensive analysis and evaluation

By comparing the seismic instantaneous frequency map and resistivity profile, the same position shows the stable high frequency characteristics corresponding to sedimentary seismic profiles, the resistivity has low resistivity (Figure 6 left), part of the corresponding complex lithology in high resistivity section (section and the left and right part). The comparison of the two shows the characteristics of the lithologic change of the seismic frequency.



**Figure 6.** contrast section of instantaneous frequency and QNK1 line resistivity of w113-01 line

Combining figure 5 and Figure 6 and conducting a structural interpretation (Figure 7), we find that the three are in conformance between the tectonic position and the lithologic change.



**Figure 7.** w113-01-line amplitude profile, instantaneous frequency section and geological map and comparison section of QNK1 line resistivity structure

The oil and gas resource survey center conducted drilling verification in the research area in 2014. Cores obtained from the wells and drilling results (Figure 7), the well about 50 meters in depth: 112.5m in coal, shale fractured bubbles, moderate intensity, rotten egg smell; 113.49-115.53m in: Shale fractured bubbles, moderate intensity, rotten egg smell; in the 115.52-116.52m shale fractured bubbles, light intensity, rotten egg smell; in 212m: fine sandstone fissure in bubbles. The above results are in agreement with the geophysical prediction results, which prove the effectiveness and feasibility of geophysical methods.

## 6. Conclusion

Through the analysis of the audio magnetotelluric data and the comparison with the seismic profiles, the following conclusions can be obtained:

Electrical test data show that limestone, dolomite and quartz vein belong to high resistivity rock mass, and metamorphic sandstone, gabbro and argillaceous limestone belong to medium high resistivity rock mass. Sandstone and mudstone belong to low resistivity rock mass. In the area of stable deposition, the quality of seismic imaging is good. Large changes in lithology and cracks will affect seismic imaging. Geophysical exploration infers that the thickness of the frozen soil layer in the flat area and other flat areas is mainly concentrated in 50 ~ 80m. In a large area of mountain ranges, the thickness of the permafrost varies greatly, between 70-120 meters. Through the comparison and analysis of seismic profiles, magnetotelluric profiles and geological data, the changes in underground structure and lithology can be better understood. By comparing with the results of drilling, the geophysical method is proved to be effective and feasible, and the conditions for the formation of gas hydrate are determined.

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