REMOTE SENSING APPLICATIONS IN PETROLEUM RESOURCES EXPLORATION FOR OFFSHORE BASINS IN CHINA

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1. INTRODUCTION

In many field surveys, it is found that hydrocarbon seepage of offshore petroleum accumulations produces distinctive alterations to discrete areas of the sea floor and sea surface. The geology of these sites suggests that the hydrocarbon seepage of offshore petroleum accumulations tends to persist at specific locations for at least hundreds of years [1][2]. Hydrocarbon seepage detection is an ideal technique for evaluating large offshore basins. According to the theory of hydrocarbon seepage, almost all known oil provinces in the world seep. In offshore basins, oil seeps escaping from petroleum accumulations arrive at the sea surface, usually in the form of oil coated gas bubbles [3], and then produce distinctive sea surface slicks identifiable from satellite [4].

The basic principle for detecting surface slicks from the SAR images is well-established. The SAR is sensitive to the sea surface roughness because of the presence of short waves. Because the reduced air-sea interaction caused by surface slicks on water, resulting in dampening of the capillary waves. The damping effect will reduce the backscattering coefficient of the sea surface, yielding a darker area in the SAR image than other sea surface [5].

Identification of petroleum resource through detection of oil seepage using radar remote sensing is a preferred technique used by international petroleum companies for their per-exploration in early stage petroleum accumulations prospecting since the space-borne SAR satellites was launched. Numerous studies have been conducted over the last twenty years to develop methods for hydrocarbon using multi-temporal SAR images in the world [6][7][8][9].

In this paper, a new data fusion approach to detection and analysis of sea surface slick caused by hydrocarbon seepage of offshore petroleum accumulations using radar remote sensing technology with diversified geophysical exploration techniques has been developed on the basis of the theory of hydrocarbon seepage, this approach is aimed at searching and locating the target areas of potential petroleum accumulations exploration of large frontier offshore basins in China. In this research Synthetic Aperture Radar (SAR) data were used as main data sources, integrating with gravity data inversed from satellite altimeter data, geophysical abnormal data from airborne magnetic data, and geological, seismic, well logging data of oil and gas bearing basins. Using the geographical information system, the oil and gas accumulating areas have been outlined and evaluated with the prediction

models. At last this approach of exploration for offshore petroleum accumulations has been applied in two study areas in offshore petroleum basins in China, *i.e.,* Bohai Sea and Pearl River Mouth basins.

2. METHODOLOGY

The proposed data fusion approach framework involves three basic procedures, *i.e.,* slicks segmentation, slicks classification and comprehensive prospect analysis. Firstly, The automatic and semi-automated segmentation was developed and applied to extract oil slick boundary by level set and fast level set method[10][11]. In addition, for the wind and ocean current condition affects feasibility and reliability in seepage detection and searching for its origin from the SAR images, a method of real-time inversing the wind speed by CMOD4 from SAR images has been developed to obtain the parameters of wind speed. Secondly, slicks classification is regarded as an important work in the slick detection. To tackle the problem, characteristics such as backscatter, texture, morphology of surface slicks identified from the SAR images with ancillary data of geological, geophysical, geochemical and geographical data were applied into slicks classification to distinguish the hydrocarbon seepage from the accumulations and those from other sources such as by oil pollution or through natural biological processes such as fish or other marine animals also shown on SAR images by analytic-hierarchic process fusion model. Thirdly, the above slicks classification results, geological, geophysical, geochemical and geographical data have been assembled into geographic information system, and overlaid for comprehensive prospect analysis.

3. EXAMPLES, ANALYSIS AND CONCLUTIONS

In the study, we selected a lot of multi-temporal ERS-2 SAR and ENVISAT ASAR images from 1996 to 2007 along with other geospatial data to identify an optimal set of parameters for detecting hydrocarbon seepage in the study areas of Bohai Sea basin and Pearl River Mouth basin. And the petroleum remote sensing analysis system has been established especially for the offshore basins in Bohai Sea Basin and Pearl River Mouth Basin. The maps of oil slick distribution and classification along with the confidence level estimates have been produced, respectively. And the spatial analysis techniques have been used to the detected surface slicks to find their relationship to geological structures and other relative petroleum accumulations data. Thereafter with the prediction models, the target areas of potential petroleum accumulations have been aimed and located and the conformation between the target areas and explored reservoirs have been analyzed.

By comparing with drilling outcomes and the relative materials, our results of Bohai Sea and Pearl River Mouth basins show that the integrated remote sensing method of hydrocarbon seepage detection is a quick and effective approach of exploration and evaluation for large frontier offshore petroleum prospective resources for offshore basins in China.

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