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Evaluation of oil sands resources ——A case study in the Athabasca Oil Sands, NE Alberta, Canada

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Abstract: Oil sands are the most important of the oil and gas resources in Canada. So the distribution and evaluation of oil sands form a critical basis for risk investment in Canada. Distribution of oil sands resources is severely controlled by the reservoir heterogeneity. Deterministic modeling is commonly used to solve the heterogeneity problems in the reservoir, but rarely used to evaluate hydrocarbon resources. In this paper, a lithofacies based deterministic method is employed to assess the oil sands resources for a part of a mining project in northern Alberta. The statistical analysis of Dean Stark water and oil saturation data and study of the core description data, regional geology and geophysical logs reveal that the lithofacies in the study area can be classified into reservoir facies, possible reservoir facies and non-reservoir facies. The indicator krigging method is used to build a 3D lithofacies model based on the classification of sedimentary facies and the ordinary krigging method is applied to petrophysical property modeling. The results show that the krigging estimation is one of the good choices in oil sand resources modeling in Alberta. Lithofacies-grade based modeling may have advantages over the grade-only based modeling.

Key words: Athabasca oil sands, deterministic method, krigging method, 3D lithofacies model

1 Introduction

Oil sands are the most important of the oil and gas resources in Canada (Carrigy and Kramers, 1973; Flach, 1984; Hein and Cotterill, 2006a, 2006b; Mossop, 1980; Ranger, 1994; Vigrass, 1968; Wightman et al, 1995). According to the Alberta Energy Department in 2009, the oil sands resources in situ are 1.7 trillion barrels of bitumen and the proven reserves are 170.4 billion barrels in northern Alberta. About 20% of bitumen resources occur in the surface mineable area[①]. Oil sands are produced from the lower Cretaceous McMurray Formation, in which the depositional environments were typical delta plains (Flach and Mossop, 1985; Ranger and Gingras, 2003). The timing of oil accumulated was earlier than oil sands resource forming (Riediger et al, 2001; Bekele et al, 2002), and biodegradation of pre-existing petroleum created the oil sands resource (Allan and Creaney, 1991; Brooks et al, 1988; Hein and Langenberg, 2003; Moshier and Waples, 1985; Mossop and Flach, 1983; Riediger et al, 2001; Rubinstein and Strausz, 1979). The distribution of the oil sands resources is severely controlled by the reservoir heterogeneity (Brekke and Evoy, 2004; MacGillivray et al, 1992; Langenberg et al, 2002; Smith, 1989). Understanding of the spatial distribution of ore and waste is the key to the mining engineering plan and design and 3D oil sands resource modeling can help understand the distribution[②] (Langenbergetal et al, 2001). Various types of modeling methods have been proposed for bitumen resource mining assessment. The modeling method we used here is a deterministic interpolation method by integrating lithofacies and bitumen grade (porosity and oil saturation). We chose a small area of about 15 sections in the Northern Lights Partnership Property for this study. This paper summarizes the method and geological analysis of oil sands resources in the study area. The hard data available for this study include core description data, Dean Stark data and geophysical log data[③]. The Northern Lights project area is located about 110 kilometers northeast of Fort McMurray in Township 98 and 99, Ranges 5 to 7 W4M (west of the Fourth Meridian) and the study area is situated in the west lease of the project area[④] (Fig. 1).

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