Polar Science xxx (xxxx) xxx

Contents lists available at ScienceDirect

Polar Science

journal homepage: www.elsevier.com/locate/polar

Gravity strike angles from EIGEN6C4 to seek conditions favourable for hydrocarbon occurrences in the Arctic zone

Jaroslav Klokočník [a,*], Jan Kostelecký [b,c], Aleš Bezděk [a]

[a] Astronomical Institute, Czech Academy of Sciences, CZ 251 65, Ondřejov, Fričova 298, Czech Republic
[b] Research Institute of Geodesy, Topography and Cartography, CZ 250 66, Zdiby 98, Czech Republic
[c] Faculty of Mining and Geology, VSB-TU Ostrava, CZ 708 33, Ostrava, Czech Republic

ARTICLE INFO

Keywords:
Earth's gravity field aspects
Arctic zone
Hydrocarbons
West Siberian basin
Lomonosov Ridge

ABSTRACT

An unusual remote sensing method is employed to seek for the sedimentary areas with possible deposits of oil/gas. The gravity aspects, derived from the global high-resolution gravity field model EIGEN 6C4, namely the strike angles, are used to detect zones on land and off-shore with a higher probability of occurrences of hydrocarbons in the Arctic zone. We utilize our previous experience with the gravity aspects applied for various geological features on the Earth, the Moon, and Mars (everywhere there our knowledge of the gravity field parameters for the respective planet is already sufficient for such a task). The West Siberian basin and Yamal peninsula nearby with known and huge oil/gas resources are used as a test bed demonstrating how our method works. Then, we extrapolate to the Lomonosov Ridge in the Arctic Ocean (till now only with scientific drilling), showing the most promising localities with possible hydrocarbon occurrences. Our results can also be used for speculations about many further untapped places in the Arctic zone with prospective hydrocarbon resources.

1. Introduction

The Arctic zone contains large, untapped oil and gas reserves (e.g., Persits and Ulmishek, 2003; USGS, 2008; Moore et al., 2011, 2019; Abdelmalak et al., 2023). Despite the harsh climate, offshore Arctic scientific drilling began in the 1970s. Various aspects of arctic hydrocarbon exploration are discussed in Gulas et al. (2017).

We contribute to hydrocarbon resources research in our own and untypical way. We employ the gravity aspects or descriptors (specific functions or transformations of disturbing gravitational potential), namely the gravity strike angles (Sect. 2.1 or Supplement 1, SM1), all derived from the disturbing static gravitational potential (Sect. 2.2). First, we shortly recall theory, data, method (Sect. 2, SM1) and then, we present our findings (Sect. 3 and S3-S5).

We selected a few of the well-known and large oil/gas fields (like Ghawar, Saudi Arabia, the Caspian Sea, Mexico Gulf and Persian Gulf). Specifically, here we work with testing our method on the West Siberian Basin (WSB) and the Yamal peninsula (Y), Russia (e.g., Ulmishek, 2003). We know that the gravity strike angles are there highly combed – linearly aligned into one direction in large areas (Klokočník and Kostelecký, 2014, Klokočník et al., 2014, 2021a). This is inspiration for us to seek for other localities of a large size and similar geological character also with highly combed strike angles. Thus, we extrapolate to the Lomonosov Ridge (LR) and nearby Makarov Basin, Alpha Ridge, Podvodnikov Basin and Amundsen Basin, SM4: slides # 4, 5, 13 in the Arctic Ocean, which is till now without any petroleum exploration. Scientific drilling on the LR and regional stratigraphic arguments suggest that oil/gas systems might be there present (Abdelmalak et al., 2023). We show that the strike angles indicate a great potential for oil/gas sources (Sect. 3). Here we confirm that the strike angles in the LR area are also highly combed, so that there is really a good chance for hydrocarbon resource (but not only there in the Arctic zone).

With the gravity aspects, we provide a cheap, preliminary diagnostic tool to identify check and study the density anomalies in a complex manner. The method has already been tested and approved over various geological features on the Earth like the impact craters, subglacial volcanoes, trenches, surface and ground water or paleolakes in Sahara (Klokočník et al., 2014, 2017a-c, 2018, 2020a-c, 2021a,b) or hydrocarbon occurrences (Klokočník and Kostelecký, 2014; Klokočník et al., 2020b, 2021a; Kadirov et al., 2023). The method contributed also to investigation of mass density variations of landforms, active orogeny and erosion in the Nepal Himalaya (Kostelecký et al., 2024). Recently, we have extended the use of the gravity aspects to the Moon (water for the *IM1* and *Artemis* missions at the southern pole, Klokočník et al. 2022

* Corresponding author.
E-mail addresses: jklokocn@asu.cas.cz (J. Klokočník), kost@fsv.cvut.cz (J. Kostelecký), bezdek@asu.cas.cz (A. Bezděk).

https://doi.org/10.1016/j.polar.2024.101157
Received 16 August 2024; Received in revised form 3 December 2024; Accepted 9 December 2024
Available online 16 December 2024