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Oil and Gas Exploration in Cuba

Geological-Structural Cartography using Potential Fields and Airborne Gamma Spectrometry

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Foreword

For any country, it is essential to conduct an ongoing assessment of potential energy and mineral resources with a view to the renewal of its exploration policy and strategy of economic development. This is based on the increase in the acquisition of new geological, geophysical, geochemical and other data (geological knowledge) and in the constant improvement of the criteria and methods of geological exploration.

From this, the tectonic-structural regionalization with purposes of oil exploration in Cuba, focusing on the mapping of potential new targets in different regions of oil-gas interest, start from the contribution of potential fields and airborne gamma spectrometry to geological-structural cartography and geological exploration, depending both on the type of geology, climate, and topography of the investigated territory. Thus, the territory of the Republic of Cuba is privileged by its contrasting alpine geology and its tropical climate, which determines the presence of residual soils and in situ developed weathering crusts and an essentially flat relief. For others, Cuba has lifted all its territory with aeromagnetic and airborne gamma spectrometry at scale of 1:50,000 and gravimetric survey on the same scale, with 80% coverage.

Each of these methods has contributed to the study of regional and local geological constitution:

- The application of the gravimetric method offers the possibility of studying the regional geological constitution, with better results for the folded belts, such as Cuba, thus permitting the tectonic regionalization, geological-structural mapping of large units and location of structures in the sedimentary cover. This is an effective means of mapping sedimentary basins and major tectonic features with which various mineral and energy resources are linked sometimes. From a local point of view, it is accepted for locating and mapping of bodies of salt, reef, granite, and ultrabasites.
- The aeromagnetic provides an aid to geological mapping of volcanogenic-sedimentary and intrusive formations in volcanic arcs, such as Cuban territory. In the presence of nonmagnetic sedimentary rocks, aeromagnetic survey data

provide information on the nature and depth of the basic-ultrabasic and/or crystalline basement. Locally, the ability to map geological-structural features is enhanced by the ability to detect low amplitude anomalies; besides intrusive bodies (granitoid) and protrusive (ophiolites) can be distinguished, often directly.

- The airborne gamma spectrometry (AGS) offers potential for mapping and subdividing acid-medium igneous and metamorphic rocks and it highlights the rock types that are characterized by unusual amounts or very low proportions of radioelements as basic–ultrabasic complex. In less radioactive environments such as volcanogenic-sedimentary terrains and sedimentary basins, the most subtle contrasts also offer reliable guide mapping. The advantage of AGS compared to other techniques of remote sensing is in mapping soil variations in areas of dense vegetation and areas of flat land. On occurrences of oil and gas, decomposition of clays in soils product of light hydrocarbons microseepage is responsible for minima observed radiation: potassium is leached from the system toward the edges of the accumulation vertical projection where precipitates result in a "halo" of high values. The thorium remains relatively fixed in their original distribution within the insoluble heavy minerals; hence, there is an observed minimum of the ratio K/Th surrounded by maximums on these deposits. On the periphery of these anomalies local increases of U(Ra) are also observed. Finally, AGS data can complement the structural interpretation of other geophysical data, playing a major role in controlling the surface geology, where some structures that do not produce magnetic and gravity anomalous responses can be deduced from these data.

The reader will find in this Monograph an interesting and valuable overview of the geology of Cuba, a synthesis of the main results in the tectonic-structural regionalization with purposes of hydrocarbon exploration, focusing on the mapping of potential new targets in different regions of oil-gas interest. Also, this book offers information on mapping geological-structural of igneous and metamorphic rock units in different regions of Cuba; all of them from potential fields and airborne gamma spectrometry data.

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Preface

A summary of the main results achieved in the tectonic-structural regionalization with purposes of hydrocarbon exploration, from data of potential fields and airborne gamma spectrometry is offered, focusing on the mapping of possible new oil-gas objectives in the regions of the Earth Blocks 9, 23 and 17–18. In some of the new places of interest (Majaguillar, Motembo Sureste, Guamutas and Maniabón) reconnaissance works were carried out by profiles of ***Redox Complex*** (complex of unconventional geophysical-geochemical exploration techniques) with positive results. Thus, Maniabón, south of the bays of Puerto Padre and Nuevitas was established as the location of main interest.

The results of the geological-structural mapping of igneous and metamorphic rocks units in the western regions (Havana-Matanzas), central (Cienfuegos-Villa Clara-Sancti Spiritus), and central-eastern (Camagüey-Tunas-Holguín) of Cuba also provide data of potential fields and airborne gamma spectrometry.

The contribution of potential fields and airborne gamma spectrometry data for geological-structural mapping of different areas of study in Cuba satisfies the well-established regularity that potential fields help, basically, to tectonic-structural deciphering of the territory and, to a lesser extent, to lithological mapping of the different units present; resulting in reverse the contribution of airborne gamma spectrometry data. Gravity data allow to identify different geological-structural features: for minimum, those associated with the Cuban North Thrust Belt, the southern metamorphic massifs, the granitic igneous bodies, the synorogenic basins and structural depressions; by highs, linked with huge thicknesses of volcanic rocks, and ophiolitic bodies; as well as by lineaments, the major tectonic boundaries within the Cuban Orogen. The aeromagnetic data allow mapping the main tectonic boundaries; the southern metamorphic massifs; the synorogenic basins and structural depressions; granitoid belts; ophiolitic bodies; and development areas of volcanic rocks. In aeromagnetics, the faculty of lithological mapping is given from the differential distribution of magnetite in various rock units. These data allow also making quantitative estimates of depth to magnetic targets. The airborne gamma spectrometry data identify, by increased values of U(Ra), units with high graphite content (organic matter), and those associated with acid igneous rocks. Increased

values of potassium are linked mainly to medium-alkaline and acid igneous rocks. Thorium increased values characterize, in general, metamorphites. Some highly developed weathering mantles on ophiolites are expressed by increments of U(Ra) and Th. Hydrocarbon deposits are expressed by minimum of K/Th ratio surrounded by maximum and, at its periphery, local increases of U(Ra) is observed.

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