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Editorial to the inaugural issue of "International Journal of Terrestrial Heat Flow and Applied Geothermics"

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The inaugural issue of the *International Journal of Terrestrial Heat Flow and Applied Geothermics – IJTHFA* is part of initiative to provide a broadened and modern perspective of geothermal research. We expect to inform scholars of recent advances, evolving trends and new ideas being put forward in our own particular areas of specialty, both for enlivened research and for training the next generations of experts. Although the academic world is increasingly driven by cross-disciplinary visions and models, the importance of intra-disciplinary views cannot be underestimated. We embrace this expanded model with the hope that it will also provide a broadened and modern perspective of geothermal research.

The decision to launch an international journal, with focus on geothermal research, was made in the context of difficulties encountered in publication of papers presented at recent meetings of the international geothermal community. The Joint Scientific Assembly of the International Association of Geodesy (IAG) and International Association of Seismology and Physics of the Earth's Interior (IASPEI), held in Kobe, Japan from July 30 through August 4, 2017. On this occasion the International Heat Flow Commission (IHFC) organized four geothermal symposia:

- S24: Methods and instruments of experimental geothermics – application and recent evolution. *Conveners: Yuri Popov and Andrea Förster*
- S25: Development and application of geothermal databases. Conveners: Shaopeng Huang and Will Gosnold
- S26: Exploring connections between heat flow and tectonics. *Conveners: Valiya M. Hamza and Makoto Yamano*
- S27: Geothermal Energy: Ground source heat pump, hydrothermal system, and hot dry rocks. *Conveners: Makoto Taniguchi and Philipp Blum*

A total of 49 papers were presented in these four symposia. Following this meeting, attempts were made to collect manuscripts based on papers presented, for eventual publication in an international journal. However, efforts for finding a suitable journal turned out to be unsuccessful.

It was in this context that a decision was made to launch an international electronic journal aimed at providing a forum for exchange of information within the geothermal community. The organizers of the International Journal of Terrestrial Heat Flow and Applied Geothermics (IJTHFA) received ten manuscripts, which after due review process were accepted for publication. Given below is a brief overview of the accepted contributions.

Overview of Accepted Contributions

The inaugural issue starts with an introductory article by **Vladimir Cermak, Alan Beck and Valiya Hamza** on the history and accomplishments of the International Heat Flow Commission during the last 55 years. It emphasizes the fact that study of the earth's internal heat plays an important role in understanding the Earth's origin, internal constitution, and plate tectonics. The outflow of heat from the Earth's interior is, energy-wise, the most impressive terrestrial phenomenon. The present rate of heat loss is estimated to be about 10^{21} J per year, i.e. several orders of magnitude greater than the energy dissipation of earthquakes or heat loss from volcanic eruptions. Knowledge of terrestrial heat flow is essential in investigating the internal thermal field of the Earth.

Initially, the focus of geothermal research has been on measurements of underground temperatures and thermal properties of geologic materials, assessment of sources and sinks of heat, institution of global database, development of thermal models of crust and qualification of geothermal energy resources. During later stages, other implications of heat flow studies have also been recognized in fields such as paleoclimatology, global warming, exploration geophysics and hydrogeology. The International Heat Flow Commission – IHFC plays a guiding role in development of such investigations.

The paper by **Fabio Vieira and Valiya Hamza** focus on the use of digital geophysical maps and GIS (Geographic Information System) techniques, employed in delimiting spatial domains of tectonic provinces and age patterns and in obtaining better understanding of global heat flow. The starting point has been a system of 1° x 1° equal longitude grid consisting of 64800 cells. Superposed on this grid system are a set of 190 polygons that approximates boundaries of tectonic provinces and another set of 137 polygons that outlines age provinces. The area extents of these polygons were determined, and heat flow values calculated for this set of "tectonic polygons" based on the empirical relation between heat flow and age of last thermos-tectonic event. The authors believe that they have found reasonable bounds in interpolations, leading to alternative representations of heat

flow on a global scale. The mean global heat flow values obtained by this procedure is found to fall in the interval of 58 to 63 mW m^{-2}. According to the results of the present work, based on reappraisal of global heat flow database and with due emphasis on observational data, the global conductive heat loss falls in the range of 28 to 35TW. This is nearly 22 to 35% less than those reported in earlier studies.

Sepehr Sangin, Günter Buntebarth, Andreas Weller, George Melikadze reports results of temperature measurements in shallow boreholes to determine the geothermal gradients for a selected set of wells in Georgia. The methodology adopted in this study is based on continuous stationary measurements with up to eight temperature sensors fixed at different depths in the wells. The temperature field was recorded during periods ranging from 16 hours to 4 days. This practice of measurements enabled detection of thermal effects of fluid flows within the selected set of boreholes. Considering the 14 wells that were selected for this study, eight showed signs of stability in temperature increase versus depth and the remaining seven wells revealed signs of instability due to subsurface fluid flows.

The work by **Maria Rosa Duque** deals with thermal structure, density distribution and lithosphere thickness in the SW part of the Iberian Peninsula, studied using data obtained in the South Portuguese Zone (SPZ) and SW border of the Ossa Morena Zone (OMZ) in the South of Portugal. Geotherms were obtained using average density values from data published. The results obtained with models based on isostasy in the region led to lithosphere thickness values between 95 and 96 km in the SPZ and a lower value of 94.5 km in the SW border of the OMZ. Analysis of geotherms shows lateral variations of temperature at the same depth. These lateral variations are compared with information obtained with seismic data.

The study by **Abdulvahab Mukhtarov**, is focused on the distribution of shallow and deep temperatures in the sedimentary cover of the South Caspian Basin (SCB). Temperature data of over 150 wells, obtained from depths varying from 100 to 6000 m in oil and gas bearing areas of Azerbaijan have been used in assessment of deep temperatures. The results reveal that low temperature areas extend from the north-west to south-east and covers low-lying areas of SCB. On the other hand, local temperature maximums are observed along the Kura Depression: in Ajinour area with an amplitude of 80°C; to the west of Kyurdamir in Sorsor and Amirarkh areas with an amplitude of 65-70°C; and in Sarkhanbeyli-Garabagly-Kyurovdag areas with an amplitude of 60-65°C.

Mohan Gupta and Sharma presents a synthesis and reinterpretation of surface heat flow values of the Rajasthan Craton(RC), north-western Indian Shield. Appreciable variations in the magnitude of heat flow are found between and within its geotectonic units, but with considerable overlap of values. The high heat flow values reported for the Proterozoic terrains of the Indian Shield is ascribed as due both to enhanced crustal radioactivity and renewed tectonic activity beneath its region. The heat flow values reported in areas of the Delhi Super Group and Aravalli Super Group are of short wavelength. In the absence of evidences of tectono-thermal events after the Neo-Proterozoic times (~600Ma) the authors conclude that observed variations in heat flow do not carry thermal transients of any recent tectonic activity.

Raisa Dorofeeva presents results of a study on the geothermal regime of the southern segment of the southern Siberian platform. Studies have also been made of the borehole thermograms and temperatures at the bottom and top of the Moti suite, of lower Cambrian age. These boreholes vary in depth from 1300 to 6000 m. Higher heat flow values are observed in the anticlinal domes and salt-dome crests, while low heat flow seems to be typical of marginal uplifts. This peculiar geothermal condition is also closely related to hydrodynamic features of the area, where underground seepage flow penetrates to depths of 3-5 km while conductive diffusion of heat prevails in the deeper crust. It is argued that such anomalous conditions exert influence on the dynamics of hydrocarbon accumulation, which in turn is also predetermined by geothermal conditions.

Diego Barbero Arianna Bucci, Paolo Chiozzi, Domenico De Luca, Maria Gabriella Forno, Marco Gattiglio, Manuela Lasagna and Massimo Verdoya give an example of the characterization of a tectonic zone by using precision underground temperature measurements. The characteristics of a tectonic discontinuity, located in NW Italy, and the lateral extension of the deformed zone have been investigated by means of analysis of thermal data recorded in wells located along the fault and other boreholes at some distance from the tectonic structure. The well intersecting the fault exhibits advection and a thermal profile that can be well matched with a model of fluid flow within a sub-vertical fracture. The other wells instead reveal prevailing conductive thermal regime. The study indicates that high-precision temperature logs can be a valuable tool for detecting fractured zones and delimit their lateral extent.

Carlos Alexandrino and Valiya Hamza report results of a study on silica content of non-thermal ground waters in obtaining estimates of heat flow for more than 500 localities, distributed over six tectonic provinces in Brazil. The procedure adopted is based on the use of an improved geo-thermometry relation for solubility of silica in ground waters. It is coupled with a revised interpretation of the empirical relation between silica content and heat flow, that allows for independent determination of the depth of circulation of groundwaters. The ranges of mean heat flow values are found to be in reasonably good agreement with those reported in earlier studies, using conventional methods. This is considered as indication that silica content of non-thermal waters may be used for obtaining reliable estimates of conductive heat flow in areas where practical limitations impede use of conventional methods.

Antonio Gomes and Jorge Gomes presents results obtained in study of deep-seated geothermal resources of the Parana basin. A 1^o x1^o grid system was adopted for data processing and in determinations of vertical distributions of excess temperatures. It has been possible to identify more than 20 crustal blocks where the resource base per unit area, referred to the accessible depth limit of 6 km, are in the range of $2x10^{11}$ to $9x10^{11}$ Joules. There are indications pointing to occurrence of medium temperature geothermal resources at

depths of 4 to 6 km in several sectors of the central and western parts of the basin. In addition, isolated pockets of high enthalpy geothermal resources are found to be present along the northwestern border. The results have also allowed better assessments of low temperature resources of the Guarani aquifer system, which span over large areas of southern Brazil, western Uruguay and northern Argentina.

Concluding Remarks

The editors of this journal are indebted to all members of the International Geothermal Community who contributed their works for publication in this issue. Special thanks are due to those who helped by reviewing the submitted manuscripts. Their comments and suggestions were most helpful in producing this volume. In particular, we extend gratitude to the Assistant Editors (Fabio Vieira and Jorge Gomes) for the hard work to ensure the timely completion of this first issue.