Category: Invited
Session: Non Linear Geophysics (NL3)

Preferred Mode of Presentation: **Oral**

On Applications of Fractal Theory in Exploration Geophysics

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The concept of fractal[1] became popular in terms of fractal geology in exploration geophysics. The scaling exponent as determined by spectrum of the source distribution contains information about the local geology hence it becomes an important parameter in geophysical exploration. Besides the possibility of using scaling exponent to distinguish different rock types its variation with depth can be useful in final interpretation of the geophysical data. Any geophysical data set can be seen as a convolution of the source distribution with a system function. To recover the source distribution by inversion from the measurements made over the surface, required prior assumptions on the covariance of the source distribution comes from the scaling exponent. In case of potential field data, scaling exponents of the field are found to be related to the scaling exponents of their respective source distribution[2]. The question of whether the scaling exponent can be used to identify different rock types has given a new aspect to the potential field power spectrum inversion. A model has been proposed for interpretation of potential field data that doesn't require any unrealistic assumption about the source distribution[3]. It can be used to invert the power spectrum and find the best values for the depth to source and the scaling exponent. However in potential field modeling, inversion algorithms based on sophisticated optimization techniques make their own requirements of causative body. Hence it is necessary to represent the causative volume economically and it should be possible to change it freely. A fractal based Voronoi tessellation technique has been proposed to allow economical representation and automatic modification of the causative volume that has been used to compute gravity response over 3-D complex geological structures, which are fractal in nature[4]. The same technique is being used for non-linear inversion of various geophysical data for fractal behaviour of sources. In this paper application of statistical as well as geometrical fractal theory has been reviewed from exploration point of view and explained in detail by various synthetic and real geophysical examples.

Keywords: fractals; scaling exponent; power spectrum; Voronoi tessellation;

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*** Organizer of the session NL3 on "Fractals and Chaotic Dynamics in Geosciences"**