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Seismic survey design for exploration of subsurface coal seams in Mazino and Parvadeh areas, Tabas, Iran

A. Kamkar-Rouhani

Shahrood University of Technology, Iran (kamkarr@yahoo.com / Fax: +98 273-3334419 / Phone: +98 273-3335509)

Seismic geophysical methods are the most developed methods in exploration geophysics. Although the methods are very costly, they have the highest resolution among geophysical methods. There are two types of seismic methods depending on the refraction or reflection of seismic waves from the interfaces between different subsurface layers: seismic refraction method and seismic reflection method. The methods are widely used in oil and gas exploration as well as engineering applications. In addition, they can be used in mineral exploration.

The use of seismic methods for coal exploration is dated to several decades ago. To trace coal seams in the subsurface, the in-seam seismic method has routinely been used since then. However, the method needs to perform in an evident coal seam (i.e. where a coal seam is exposed in the surface or underground excavations). It is just recently that the surface seismic surveys using the seismic reflection method have been applied successfully in exploration of coal seams at depths of tens or hundreds meters. In this paper, this new application of the seismic reflection method is discussed, and a suitable design of seismic survey parameters in a large coal region in Iran is explained in detail.

The aim of using the seismic reflection method for investigation of coal areas is generally to delineate subsurface geological structures or layers, and specifically to recognize subsurface coal seams and determine their thicknesses. To achieve this aim, seismic surveys based on the method in Mazino and Parvadeh areas from Tabas coal region have been designed. The design parameters can also be used in other areas of Tabas coal region where exploration operations have not been started yet.

Moderate topographic conditions in Mazino and Parvadeh areas have made it practi-

cally easy to spread seismic equipment on the surface and record easily seismic reflected waves by geophones in the areas. However, there are some reasons or factors, which impede the use of the seismic surveys in the areas, or limit the success of the surveys. One of the reasons is that coal exploration has been carried out in the areas by drilling an extensive and relatively dense borehole network up to depth of 500 m. Thus, it is said that there will be no need to perform seismic surveys to explore coal seams in the areas since all the seams up to depth of 500 m have been explored. The only justification for applying the seismic reflection method in the areas is to explore coal seams, if exist, below depth of 500 m, which seems almost impossible because of small thicknesses that the seams may have. Having this, the seismic surveys in the areas can also be used for testing and research purposes, for example, to see the accuracy of thickness estimation of the coal seems in different depths by interpretation of seismic data. It should be noted that the seismic method, although much cheaper than drilling method, it is an indirect exploration method which determines the thicknesses of coal seams approximately, opposite to exact thickness determination of drilling method as a direct exploration method. Also, there should always be some boreholes drilled to confirm the results of seismic data interpretation or to remove or reduce the ambiguities arising from the interpretation of the seismic data. Another important factor for having success with seismic method in coal areas is that there should be sonic and density variations in coal seams. Although density logs have been obtained from the boreholes in Mazino and Parvadeh areas, unfortunately no sonic logs have been obtained from the boreholes in the areas. Therefore, before commencing the seismic reflection surveys in the areas, sonic logs should be obtained from the boreholes.

Design of seismic reflection survey parameters in the above-mentioned coal areas has been analyzed thoroughly in this paper. The minimum requirements of seismic measuring equipment especially specifications of geophones used for the survey, type of seismic source (i.e. type and size of explosive material) used for the survey, types of seismic arrays or survey layout suitable for the survey, recording or sampling intervals, and noise levels, their effects on seismic acquisition data and methods for reducing them are the most important of the parameters which will be discussed in detail in the paper. It is necessary to say that the seismic parameters for hydrocarbon exploration are quite different from those for coal exploration. If seismic surveys in coal areas are employed using seismic parameters which are suitable for hydrocarbon exploration, the results will not detect or explore coal seams in the subsurface.