

A STUDY OF LAND SUBSIDENCE BY RADAR REMOTE SENSING AT DATONG JURASSIC & CARBONIFEROUS PERIOD COALFIELD*

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ABSTRACT

Historical records in the Shui Jing Zhu and other classics from Tang Dynasty indicates that the local people began coal mining activities for warming and metallurgical purposes in the DATONG coalfield as early as 1500 years ago. As one of the biggest coal mining bases in China, presently the DATONG coalfield has already established an annual productivity of 104.1 million tons of crude coal. The heavy mining activities in its Jurassic & Carboniferous coal seams has caused very serious adverse effects to the local geological environment, such as soil avalanche, landslide, mud-rock flow, surface settlement, surface crack, surface gangue stack, surface deformations and subsidence. Moreover, as coal mining causes groundwater leakage, excessive groundwater exploitation has greatly intensified surface settlement in DATONG City.

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With the help of radar remote sensing such as InSAR, D-InSAR, PS-InSAR and CTM-InSAR, and assisted by optical remote sensing method of geological environment investigation and the conventional geological environment investigation, this paper successfully obtains abundant statistics of the background geological environment of DATONG Jurassic & Carboniferous Period coalfield, as well as data of local dilapidation, landslide, much-rock flow, surface subsidence, ground crack and coal or offal stack. Evaluation of these information will provide a technology support for regional geological environmental protection, geological disaster control and prevention, national territory improvement and the environment optimization.

The paper uses 8 cog-nominal ERS-1/2 SAR data frames obtained during 1992 to 2003 period, and analyzed them from the following approaches. Firstly, using multi-temporal SAR magnitude images, the geological structure, vegetation, micro-geomorph and the river system are interpreted, and the possible geological disasters are predicted. Secondly, using multi-temporal InSAR coherent images, surface features are classified, and the coherence change due to coalmining activities are evaluated. Thirdly, using multi-temporal cog-nominal SAR images, a series of differential deformation fields are extracted by D-InSAR. In the end, using multi-temporal cong-nominal SAR images, a 10-year time series of differential interferograms are obtained.

Altogether 84 deformation fields are obtained, which occurred in the periods of 1993-1996, 1996-1997, 1997-1998, 1998-2001, 1998-2002, and 2001-2003 respectively. Of the 84 sites for preliminary interference, 44 sites belong to mining subsidence, 23 urban subsidence and 17 landslide. The total coverage area of deformation amounts to 1824.4km², which is almost equivalent to the total area of the DATONG coalfield.

Furthermore, in order to verify the InSAR deformation field of mining subsidence, geodetic surveying and field investigation are carried out in some selected subsidence areas, namely the Dongzhouyao mine and Tiefeng mine of the Datong Coal Mining Group. Comparison results show that the location and scale of the deformation areas are in good conformity with the realities. In conclusion, although researching characteristics of maximum subsidence ($W_{\max} = Mq \cos \alpha$), maximum horizontal movement ($U_{\max} = \pm b W_{\max}$),

maximum tilt ($i_{\max} = \pm \frac{W_{\max}}{r}$), maximum curvature ($K_{\max} = \pm 1.52 \frac{W_{\max}}{r^2}$), and maximum horizontal deformation

($\varepsilon = \pm 1.52b \frac{W_{\max}}{r}$) have to rely upon InSAR results. So now InSAR is still the only feasible technical approach for large scale

measurement of land subsidence of strictly determined areas of tens of thousand square kilometers over a long period of time range over ten years.

Key words: Land subsidence; InSAR; DATONG Jurassic & Carboniferous Period Coalfield