Advances in Reservoir Monitoring Using Satellite Radar Sensors

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SUMMARY

Surface deformation monitoring can provide valuable constraints on the dynamic behaviour of a reservoir, by allowing the evaluation of volume/pressure changes with time, as well as an estimation of reservoir permeability. Levelling campaigns, tiltmeters, GPS and InSAR are all geodetic techniques used to detect and monitor surface deformation phenomena. Among them, InSAR data from satellite radar sensors are gaining increasing attention for their unique technical features and cost-effectiveness. In particular, Permanent Scatterer InSAR (PSInSAR) is an advanced InSAR technique, developed in the late nineties, capable of providing very precise 1D displacement measurements along the satellite line-of-sight (LOS) and high spatial density (typically exceeding 100 measurement points/sqkm) over large areas, by exploiting point-wise radar targets already available on ground. PSInSAR' data have been already used successfully for environmental assessments, reservoir monitoring in CO2 sequestration experiments (Vasco et al. 2008, Mathieson et al. 2009), as well as for the analysis of gas storage areas.

Recently, some significant advances have been reported in InSAR data processing that can further increased the quality and the effectiveness of this data source for reservoir monitoring:

(a) the development of new InSAR algorithms and in particular the so-called SqueezSAR' approach. This new approach allows a significant increased in the spatial density of measurement points, as well as an improved quality of the time series of deformation;

(b) the availability of an increased number of satellite radar sensors characterized by higher sensitivity to surface deformation (compared to previous available sensors), higher spatial resolution (down to 1 m), as well as better temporal frequency of acquisition (down to a few days, rather than a monthly update);

(c) the possibility to combine 2 or more data-stacks acquired along different satellite orbits to estimate the 3D displacement vector, rather than a set of 1D deformation measurements along the satellite LOS.

In this paper all three topics mentioned above will be addressed giving some insights on the potential impacts for reservoir monitoring and CO2 sequestration.