Available online at www.sciencedirect.com
SCIENCE DIRECT
Engineering Geology 68 (2003) 3–14
ENGINEERING GEOLOGY
www.elsevier.com/locate/enggeo

Monitoring landslides and tectonic motions with the Permanent Scatterers Technique

Carlo Colesanti [a,b,1], Alessandro Ferretti [a,b,*,1], Claudio Prati [a,b], Fabio Rocca [a,b]

[a] *Dipartimento di Elettronica e Informazione, Politecnico di Milano, Piazza Leonardo da Vinci, 32-20133 Milan, Italy*
[b] *Tele-Rilevamento Europa-T.R.E. S.r.l., Piazza Leonardo da Vinci, 32-20133 Milan, Italy*

Received 2 October 2001; received in revised form 1 March 2002; accepted 5 April 2002

Abstract

Spaceborne differential synthetic aperture radar interferometry (DInSAR) has already proven its potential for mapping ground deformation phenomena, e.g. volcano dynamics. However, atmospheric disturbances as well as phase decorrelation have prevented hitherto this technique from achieving full operational capability. These drawbacks are overcome by carrying out measurements on a subset of image pixels corresponding to pointwise stable reflectors (Permanent Scatterers, PS) and exploiting long temporal series of interferometric data.

Results obtained by processing 55 images acquired by the European Space Agency (ESA) ERS SAR sensors over Southern California show that the PS approach pushes measurement accuracy very close to its theoretical limit (about 1 mm), allowing the description of millimetric deformation phenomena occurring in a complex fault system. A comparison with corresponding displacement time series relative to permanent GPS stations of the Southern California Integrated GPS network (SCIGN) is carried out. Moreover, the pixel-by-pixel character of the PS analysis allows the exploitation of individual phase stable radar targets in low-coherence areas. This makes spaceborne interferometric measurements possible in vegetated areas, as long as a sufficient spatial density of individual isolated man-made structures or exposed rocks is available.

The evolution of the Ancona landslide (central Italy) was analysed by processing 61 ERS images acquired in the time span between June 1992 and December 2000. The results have been compared with deformation values detected during optical levelling campaigns ordered by the Municipality of Ancona.

The characteristics of PS, GPS and optical levelling surveying are to some extent complementary: a synergistic use of the three techniques could strongly enhance quality and reliability of ground deformation monitoring.

Keywords: Permanent Scatterers Technique; Synthetic aperture radar interferometry; Landslides; Tectonics; Monitoring

1. Introduction

The interferometric approach is based on the phase comparison of synthetic aperture radar (SAR) images, gathered at different times with slightly different looking angles (Gabriel et al., 1989; Massonnet and Feigl, 1998; Rosen et al., 2000; Bamler and Hartl, 1998). Theoretically, it has the potential to detect millimetric

* Corresponding author. Dipartimento di Elettronica e Informazione, Politecnico di Milano, Piazza Leonardo da Vinci, 32-20133 Milan, Italy. Tel.: +39-22-3993451; fax: +39-22-3993413.
E-mail addresses: aferrett@elet.polimi.it, alessandro.ferretti@treuropa.com (A. Ferretti).
[1] Tel.: +39-22-3993451; fax: +39-22-3993413.

PII: S0013-7952(02)00195-3