

*ORFEO Preparatory Program –*  
**WG 4 « GEOLOGY - GEOPHYSICS »**  
–  
*Toulouse – June 10 2006*

**Composition**

Christophe DELACOURT : Institut Universitaire Européen de la Mer UBO/CNRS

Pierre BRIOLE : CNRS/INSU Geoscope

Claudie CARNEC : BRGM

Rémi MICHEL : CEA/DASE

Eric GASTINE : SOLETANCHE-BACHY SOLDATA

Stéphane BAIZE : Inst. Radioprotection & Sûreté Nucléaire

Yann KLINGER : IPGP Département de Tectonique

Michel GAY : CNRS/Laboratoire des Images et des Signaux

Selma CHERCHALI : CNES

Steven Hosford : CNES

**Specificity** :

Most of the participants of this WG are at the boundary between «Thematicians » and « Methodologists » (SAR Interferometry, image correlation, image processing....)

**Thematic domain**

**Vulcanology**

**Seismotectonic:** Field that bridges earthquake seismology and plate tectonics

**Cryosphere :** The Earth' s cryosphere includes sea ice, freshwater ice, snow, glaciers, frozen ground and permafrost.

**Gravitating Motions**

**Landslide :** rock, earth, or debris flows on slopes due to gravity

**Subsidence:** Natural and anthropic

**Erosion**

What we want to do with VHR satellite images :

**Imagery of active faults – Seisms**

- Faults maps
- Co-seismic and Post-seismic surface displacement maps
- Damage maps

**Gravitating Motion**

- Detection ; Maps ; Monitoring displacement

**Volcanology**

- To follow temporal evolution

**Subsidence**

- Detection ; Monitoring displacement

**Erosion Susceptibility**

- Erosion rate estimation

**Cryosphere**

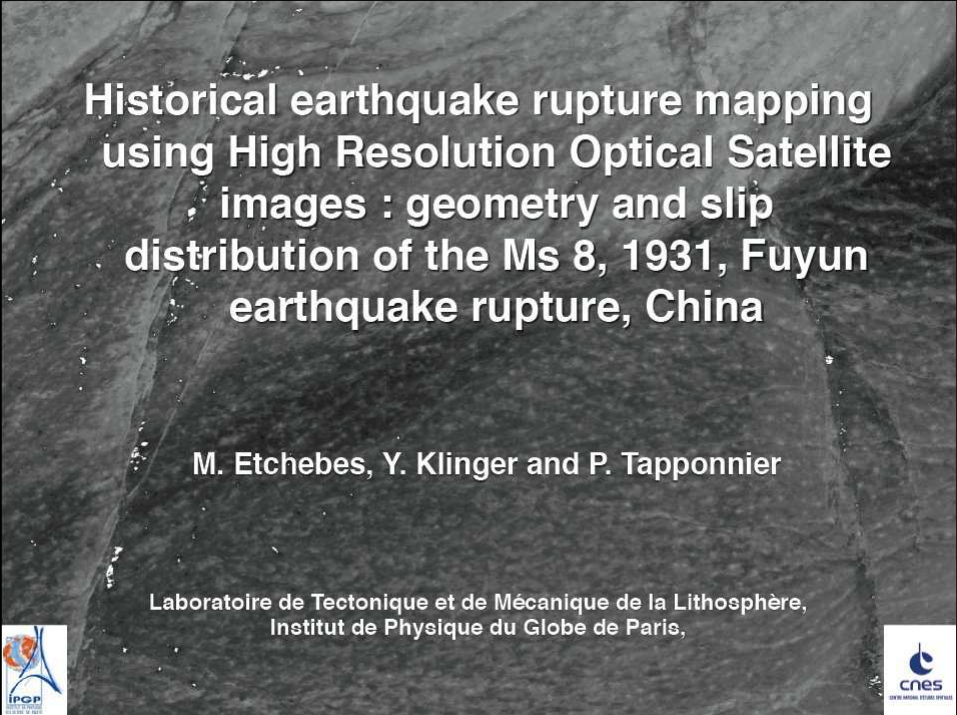
- Glacial lake detection and evolution
- Antarctic coastal boundary evolution
- Glaciers evolution (Alps, Himalaya Antarctic)

- Main Requirement of WG4 :

- Quantification of change and motion (correlation, DEM's...)
- No specific requirement for automatic detection of objects (excepted for few elements : faults, lava flows, glacial lakes...)
- High temporal acquisition in similar orbital conditions  
Specific acquisition periods (Glaciers, landslide, volcanoes..)
- Knowledge of radiometric and geometrical parameters of images  
(orbitography, image quality...)
- DEM and DSM in natural context with metric spatial resolution and accuracy
- Build up of Archive (Seisms...)
- In case of crisis: reduction of time between request and image download

## 2 Thematic Studies

- High spatial resolution cartography of geological surface and Surface deformation cartography associated to the Fuyun Area (China)
- Potential of multitemporal image correlation for surface displacement maps



**Historical earthquake rupture mapping  
using High Resolution Optical Satellite  
images : geometry and slip  
distribution of the Ms 8, 1931, Fuyun  
earthquake rupture, China**

M. Etchebes, Y. Klinger and P. Tapponnier

Laboratoire de Tectonique et de Mécanique de la Lithosphère,  
Institut de Physique du Globe de Paris,



## **Problematic**

- Attempt to map a 77 years old surface rupture using High Resolution Satellite images

In order to describe the geometry and the slip distribution associated with the 1931 Fuyun earthquake

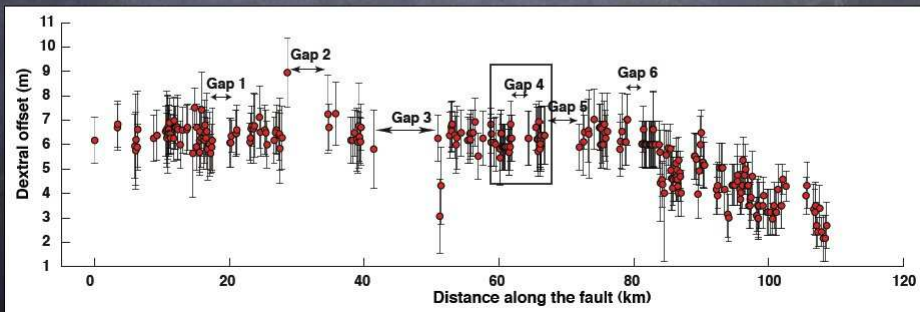
- To better constraint dynamic rupture models :
  - Many models of seismic cycles
  - Models validation is difficult due to a lack of data

### Offset measurement: Example 1



Lateral offset :  
 $5.9 \pm 0.6$  m

### Coseismic slip distribution along the 1931 Fuyun rupture





## Conclusions



- Detailed mapping of 77 yrs old surface rupture using High Resolution Satellite images.
- Important tools because :
  - Overall picture of the earthquake rupture (of great length located in remoteness area).
  - Detailed analysis of the associated coseismic and cumulative deformation.
  - Key to assess more systematically the role of discontinuities on the rupture propagation in order to better constraint dynamic rupture models.
  - Fast, global and unique information to study large earthquake.

## Perspectives

- Go on the field to check our measurements and to date the offsets in order to check our seismic cycle assumption.
- Apply this method to other old ruptures to complete their slip distribution curve and in the end to better constrain the seismic cycles in order to assess the earthquake hazard.
- Do and understand, on a very large scale, the seismic sequences of Asian continental faults.

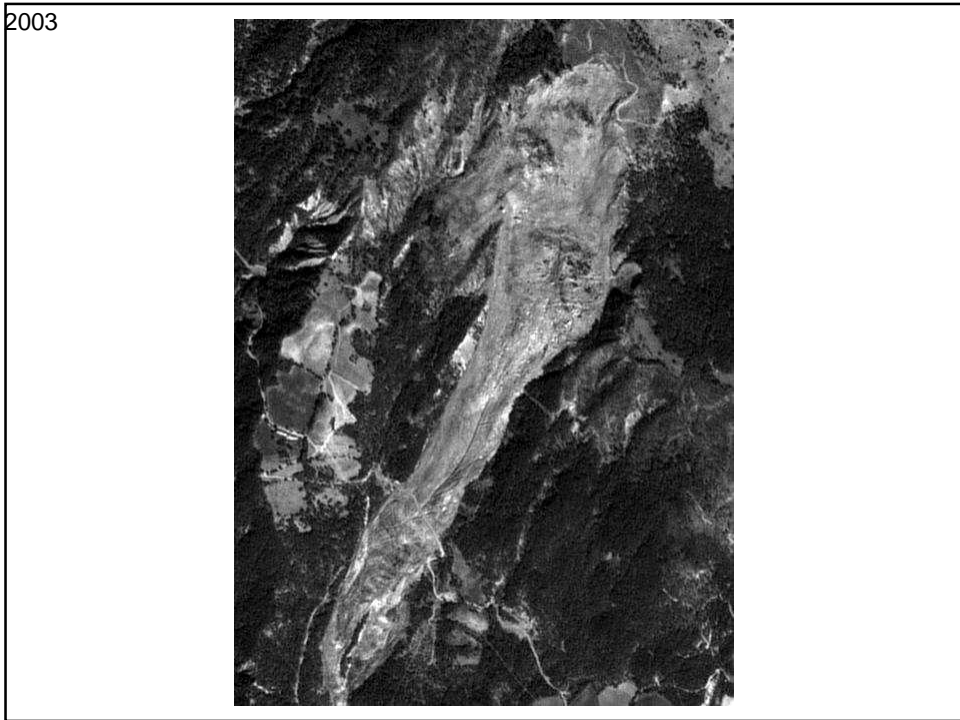


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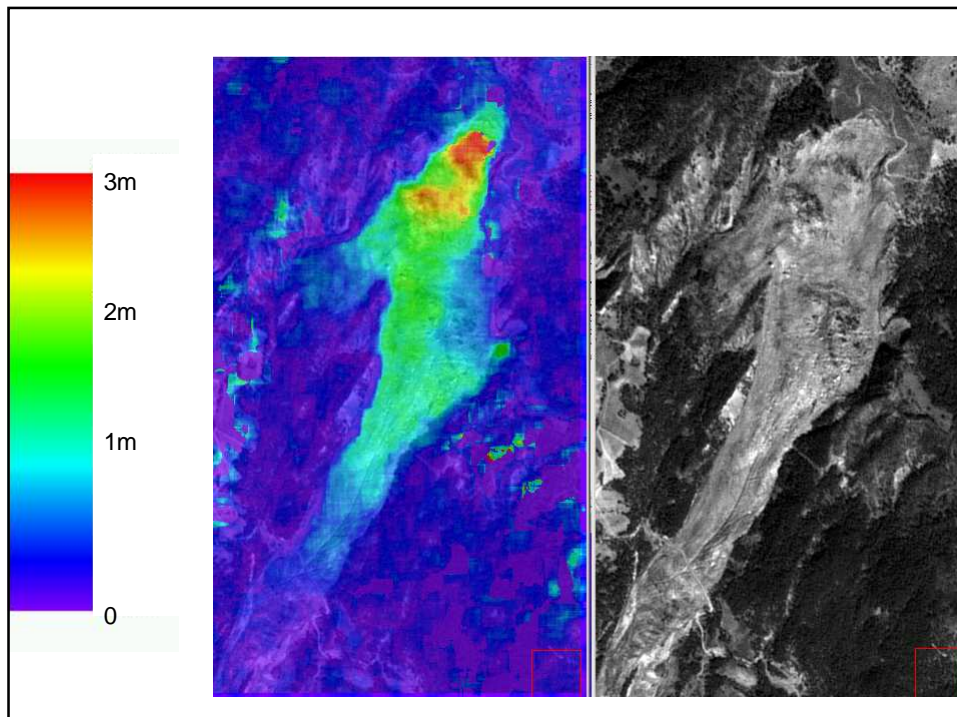
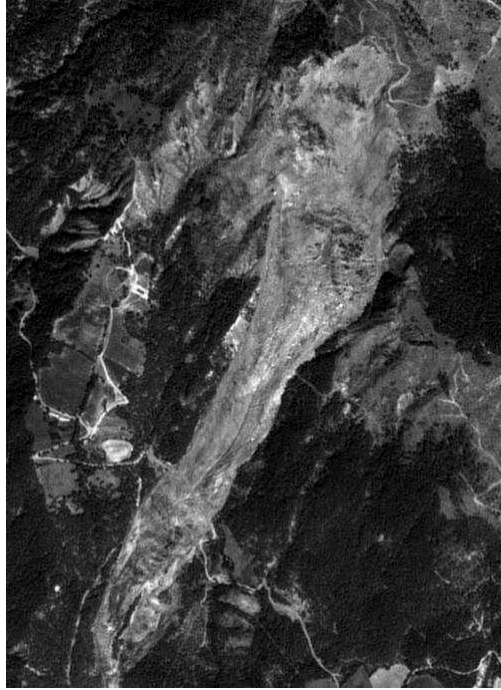
 

**VHR multitemporal images correlation  
for surface displacements  
maps derivation**

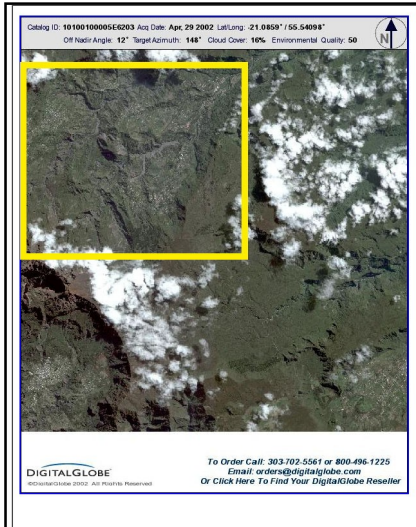
[Christophe.delacourt@univ-brest.fr](mailto:Christophe.delacourt@univ-brest.fr)



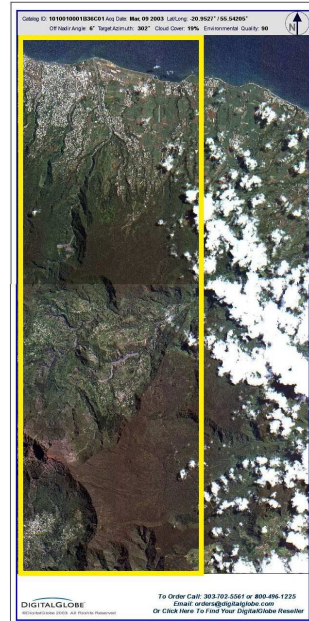
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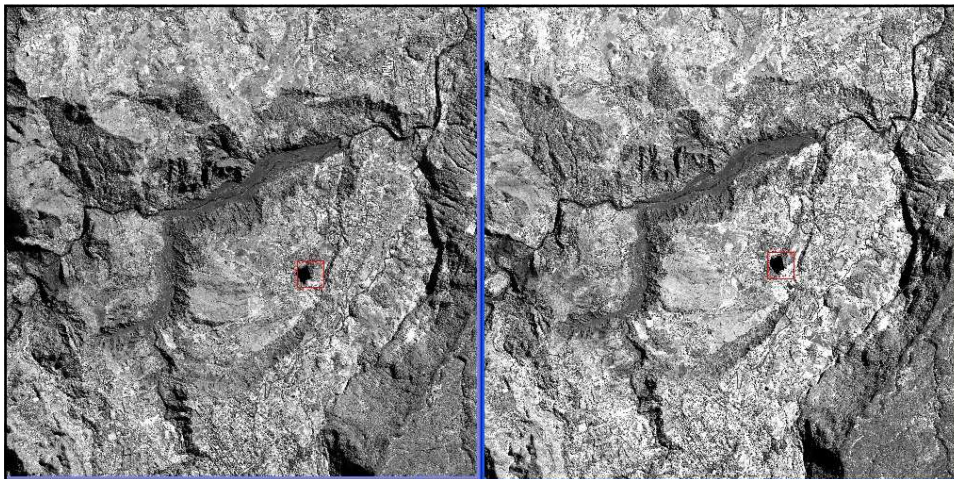




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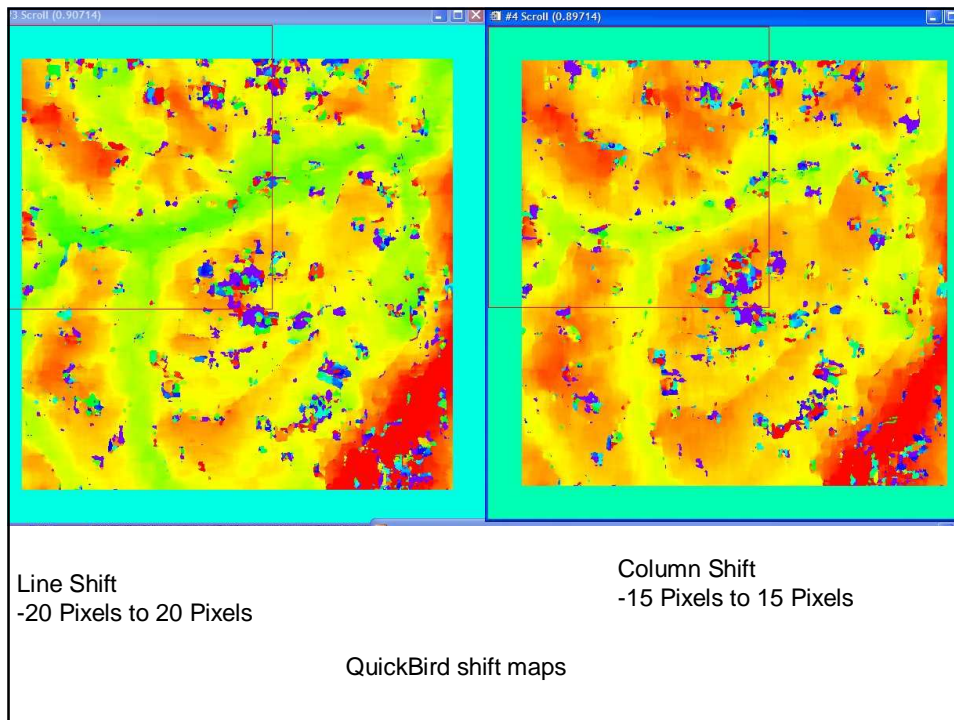


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### **Conclusions**

- Optical image correlation has been successfully applied to a wide field of applications (volcano, landslide, earthquake, glaciers...)
- However this technique requires specific constraints on image acquisition :
  - High repeatability acquisitions with various time spans and period acquisition
  - Similar orbital configuration
  - Image (geometrical / radiometric) information
  - Archive
- Actually it is very difficult to obtain such type of data with SPOT 5 (acquisition constraints....)
- Geophysics community hope that it will be better with Pleiades.....