MORPHOLOGICAL SEGMENTATION APPLIED TO 3D SEISMIC DATA

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Abstract Mathematical morphology tools have already been applied to a large range of application domains: from 2d grey-level image processing to colour movies and 3D medical image processing. However, they seem to have been seldom used to process 3D seismic images. The specific layer structure of these data makes them very interesting to study. This paper presents the first results we have obtained by carrying out two kinds of hierarchal segmentation tests of 3D seismic data. First, we have performed a marker based segmentation of a seismic amplitude cube constrained by a picked surface called seismic horizon. The second test has consisted in applying a hierarchical segmentation to the same seismic amplitude cube, but this time with no *a priori* information about the image structure.

Keywords: 3D seismic data, mathematical morphology, hierarchical segmentation

Introduction

The application of image processing techniques to seismic 3D data has always been impaired by the huge volume of these data. However, recent algorithms and hardware performance improvements can partly solve this problem and seismic imaging is a domain that is expanding at present.

To our knowledge, morphological tools have been very rarely applied to 3D seismic data. This paper describes the first promising results of the application of morphological segmentation to seismic data.

The first section of the paper is devoted to the presentation of some generic information about seismic acquisition and processing techniques. In the second

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section, we briefly describe the morphological tools we have used to achieve our tests. The applications of these tools to seismic data and their results are also presented in this section.

1. Seismic imaging

Seismic reflection

Seismic images result from acoustic propagation techniques. A surface source generates an acoustic signal into the subsurface of the earth. The signal propagates in the subsurface and is partly reflected by interfaces between rock layers of different acoustic impedance. The intensity of the reflected signal is proportional to the intensity of the impedance contrast. The residual part of the signal that is not reflected is transmitted and continues to propagate in the subsurface until it is reflected and transmitted by a new impedance contrast interface, and so on. The reflected part of the signal is recorded by several sensors located on the surface. This recorded information is processed, leading to an intensity - called amplitude - image of the subsurface. An interesting "echography" is then available thanks to this acquisition and processing technique. More information on seismic reflection techniques can be found in [8].

For years seismic data processing has been connected with image and signal processing. Among the techniques applied to seismic images, we find, for example, region growing and wavelet analysis [2, 7] which have been tested only on 2d data sets. On the contrary, mathematical morphology seems to have been rarely used to process seismic images.

3D seismic images

Common seismic 3D images are 16 bits amplitude images. They often contain several hundred millions of samples. A seismic image is defined by three main axes. The two horizontal ones are called inline and crossline. They correspond respectively to the acquisition direction and to the direction perpendicular to the acquisition direction. The vertical axis represents time (more or less equivalent to the recorded time of the reflected signal) or depth (after time to depth conversion).
As these images typically correspond to sedimentary underground, they are composed by a sequence of high intensity and low intensity surfaces roughly horizontal, called seismic horizons, which can be cut by faults (see *figure1(a)*).

Seismic Horizon

For the first test, we have chosen to work more specifically on a seismic interpretation context: horizon picking. Considering seismic amplitude images as grey level images, horizon picking consists in extracting continuous