ENHANCED SEISMIC METHODS FOR MARINE HAZARD SURVEYS

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ABSTRACT

Using results obtained from existing 3-D marine seismic surveys acquired with a compact recording geometry we show how true-amplitude migration processing can yield remarkably well-defined images of the shallow geology in plan view. Examples of such images are presented showing features of small physical dimensions, as well as a number of responses that are presumed to represent gas hazards. The pictorial quality of intensity-modulated time slice displays is particularly striking. In many cases small yet potentially important targets could remain unsampled by the customary grid of 2-D survey lines, or would be virtually uninterpretable without the benefit of 3-D migration. Even when 3-D methods have been applied, conventional seismic cross sections are inappropriate for displaying responses resulting from fractures or channels that have a small spatial footprint. Commonly, these will remain unnoticed or be dismissed as noise in a vertical seismic profile. The Short-Offset field technique that we propose for this work can be economically applied to hazard surveys. Results suggest that the temporal bandwidth commonly specified for shallow profiling can probably be relaxed when areal
data recording methods are applied. Routine application would reasonably be expected to reduce drilling costs whilst significantly improving safety.

INTRODUCTION

Seismic techniques as applied to hazard surveys are essentially the same as those used for deep exploration, differing primarily in scale. The seismic source, record length, and sample rates both spatial and temporal, are adjusted to suit the shallower depths of investigation and the broader signal bandwidth that is expected to apply. Recording instrumentation, processing, and final display methods also follow those employed for conventional surveys, resulting in a grid of intersecting 2-dimensional vertical profiles.

An immediate question concerns the suitability of the conventional seismic cross section display for site survey applications. Of principle interest in these studies is the detection of amplitude anomalies and determination of their spatial extent. A further aim is to establish the competence or otherwise of shallow formations, as may be indicated for instance by evidence of faults or fractures. We hope to demonstrate that these objectives are better realised using sequences of horizontal seismic profiles displayed in variable intensity mode.

In order to generate horizontal profiles it is of course necessary to acquire seismic data over a closely sampled area, such as is regularly accomplished for conventional 3-D seismic surveys. For shallow objectives, however, long streamers and large fold of common mid-point (CMP) stack are unnecessary and much of the complexity associated with 3-D marine seismic surveys is thus avoided. Indeed, the hazard survey appears to be an ideal application for the so-called Short-Offset 3-D method described by Newman (1984, 1985, 1988, 1989.).

A key requirement of the Short-Offset method is to approximate normal-incidence reflection responses, as nearly as is practicable, by operating with the minimum source-receiver separation that is consistent with tow noise and