#### Near-vertical oil & gas conduits and traps – new prospects...



Oil & Gas Journal / Nov. 21, 2005 Data Integration vital in exploring for diagenetic traps Robert G. Hickman, Structural Solutions, Houston W. Norman Kent, Kent GeoScience Associates, Richmond Tex. Basement-involved faults, particularly faults that are reactivated over time, form some of the most important zones of vertical permeability...

HIGH VERTICAL PERMEABILITY AT FAULT INTERSECTIONS/INTERACTION ZONES

Ein. 7

D Duplex Wave Migration [in Tesseral 2D]

Canadian Journal of Remote Sensing, Vol. 17, No. 2, April1991 MAPPING OF BASEMENT AND OTHER TECTONIC FEATURES USING SEASAT AND THEMATIC MAPPER IN HYDROCARBON-PRODUCING AREAS OF THE WESTERN SEDIMENTARY BASIN OF CANADA By K.S. MISRA, V.R. SLANEY, D. GRAHAM, J. HARRIS

Lineaments, together with available magnetic, geological and oil and gas well data, are correlated with structures in the sedimentary cower and underlying basement in a search for hydrocarbon prospects...







Seismic images of sub-vertical reflecting boundaries built with duplex reflections by wave type vh(e), hv (f) and stacked seismic image (g).

#### DIFFERENTLY ORIENTED SMALL-THROU FAULTS IN THIN-LAYERED MEDIUM



Source models

Seismic image of cross-section with conventional pre-stack migration

Seismic image of faults with duplex wave pre-stack migration

Modeling shows that there are cases where we do not see the faults in the conventional data: but there is a technique that does

Theory



#### SEISMIC IMAGE BUILDING FOR SIDE WALL OF THE SALT DOME



**Fig. 2** Seismic wavefield snapshots (with arrows are shown duplex reflections from boundaries highlighted with red lines).

 $T_0$ , ms

(with arrows are shown duplex reflections). X, m 2000 X, m X<sub>sp</sub>, m T, ms

Fig. 3 Synthetic shotgathersFig. 4 Seismic image of cross-section by(with arrows are shown duplex reflections)conventional CSP migration transformation.

T₀, ms

**Fig.** 5 Seismic image of side wall of the salt dome by Duplex Wave Migration .

#### Velocity analysis using DWM

#### W1 575 825 1825 1075 575 325 2075 2325 11 9 14 16 19( 0.0 0.0 <u>, i i a canada da da da cu cu c</u>a ο. 0.1 0.: 0.2 0.3 ο. 0. 0. 0.9 V=2650 0.9 0.4 0. 0.2 0.2 ò. 0.5 0. о. ο. 0.2 0. 0.3 ο. o.ο. V=2750 0.5 o.: o., 0. 0.2 0.7 0.4 ο. 0.5 0.5 0. 0. o.: 0.3 TILKY N PR 0. Uľ, V=2850 0.9 0.5 0.. 0. 0.2 ο. 0.4 0. ο. 0.5 ο. : о. 10.1 о. 0.3 **True velocity** о. ь. 0.5 D.1 V = 2950 m/sD.o., 0.2 o.: 0.4 0.8 0.9 0.9 n verver tealaintik a frainsi dikeen o. : 0.1 0.3 0.2 ο. ο. 0. 0. V=3050 likiu 0.5 0.5 ο. ο. 0.7 0.2 1.111.5 0.4 ο. 0.5 n.



5

#### THEORY

#### SEISMIC IMAGING OF FAULT SERIES IN ROUGHLY-BLOCKED CROSS-SECTION STRUCTURE

# Seismic images of faults

With duplex wave migration by reflections of type "HV"

With duplex wave migration by reflections of type "VH"



#### **Building of sub-vertical boundary images by Duplex** Wave Migration for real 2-D data



**APPLICATION** 

#### **APPLICATION**



Migrated time cross-section along profile 25 2799  $B, B, \Gamma$  – faults delineated using DWM technique

8

**APPLICATION** 



Seismic image of **sub-vertical boundaries obtained using DWM along 15 2783 profile** (schemes PL,IL): a) base boundary - horizon  $VB_2$ ; b) base boundary - horizon  $VB_4$ .



Seismic image of sub-vertical boundaries obtained using DWM along 25 2799 profile (schemes IL): base boundary - horizon  $VB_2$ ; b) base boundary - horizon  $VB_4$ .

### **Duplex wave migration for VSP data**



Schemes of duplex waves at VSP (a), image of vertical boundary (b), obtained in result of depth duplex waves migration of VSP data



A – model (shot point X=1200m, Well X=700m, fault X=500m),

b - image of vertical boundary, obtained by one-time reflected waves,

c – image of vertical boundary, obtained by duplex reflected waves.

## Summary

• Depth pre-stack migration of duplex waves is a new tool for identifying and tracing near-vertical discontinuities of various natures. It uses *conventional reflection seismic observation geometry and data*.

• It is an important channel of seismic information for mapping of salt dome flanks and different kinds of near-vertical discontinuities, including fracturing zones and faults with small amplitudes.

• **Results of its application** have been presented in various publications and conventions and **found numerous proofs**.

Migration of Duplex Waves Society of Exploration Geophysicists International Exposition, Huston, Texas, 2005. N. MARMALYEVSKYY, Y. ROGANOV, Z. GORNYAK, A. KOSTYUKEVYCH, V. MERSHCHIY

See also presentations about 3D Duplex Wave Migration & Applications (by TetraSeis Inc.)