Seismic Reprocessing challenges, observations and solutions for Sinu, San Jacinto Areas, Colombia

AGT Inc., October 21, 2022

Area to focus – Snapshot of the data

Searcher

AGT SEISMIC IMAGING BELOW + BEYOND
ADVANCED GEOPHYSICAL TECHNOLOGY

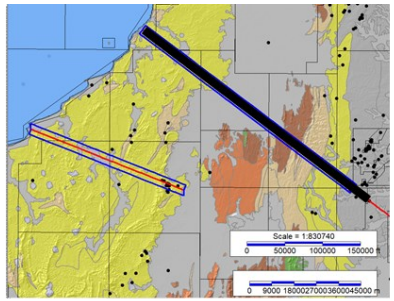
ANH
AGENCIA NACIONAL DE HIDROCARBUROS

Rough topography
- Statics - near surface refractors, subsurface events
- Signal alignment difficult

Thrusted environment
- Rapidly changing velocity due to highly structured geology

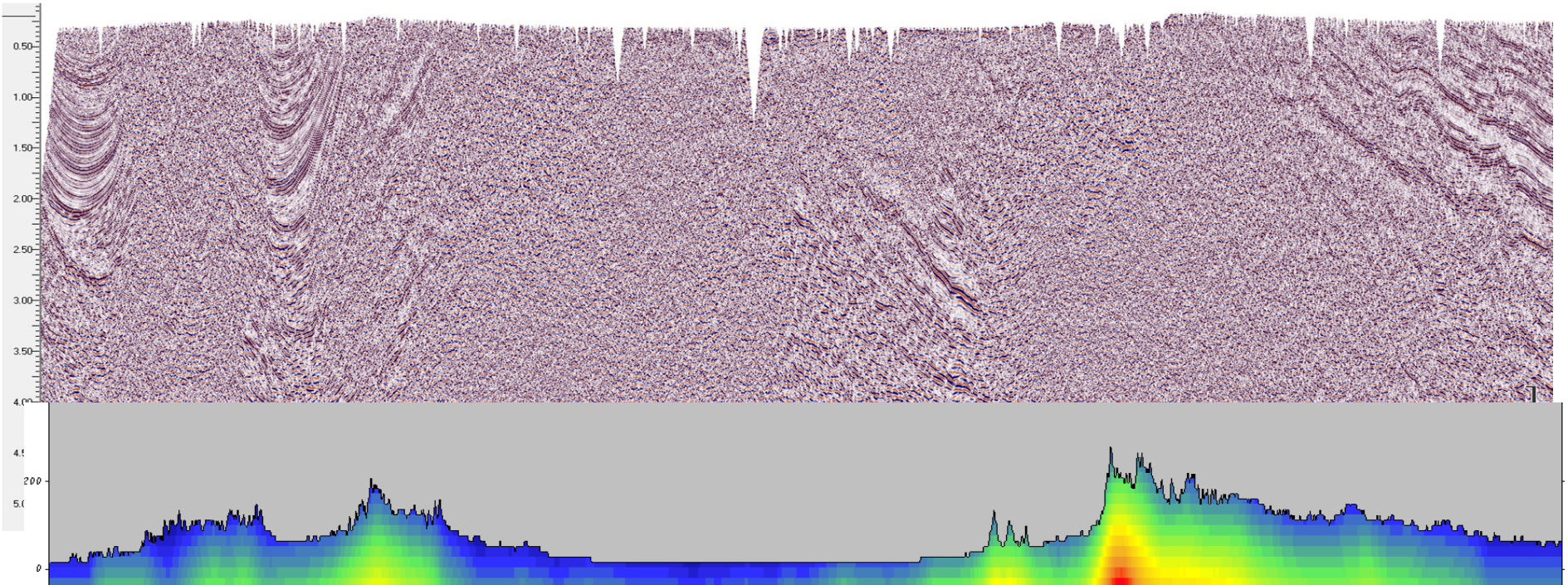
Poor signal : noise
- Penetration of source – Dynamite, Vibroseis
- Dissipation of source energy

Legacy Acquisition Methods – 1970's – 2000's
- Limited / Poor offset distribution – longer offsets preferred



LMB

NW



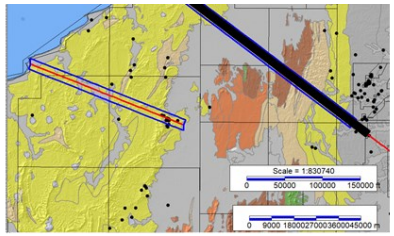
Additional Challenges –
Logistics of Understanding Data: 1970's – 1990's

Older data acquisition methods for recording relied mainly on manual data entries

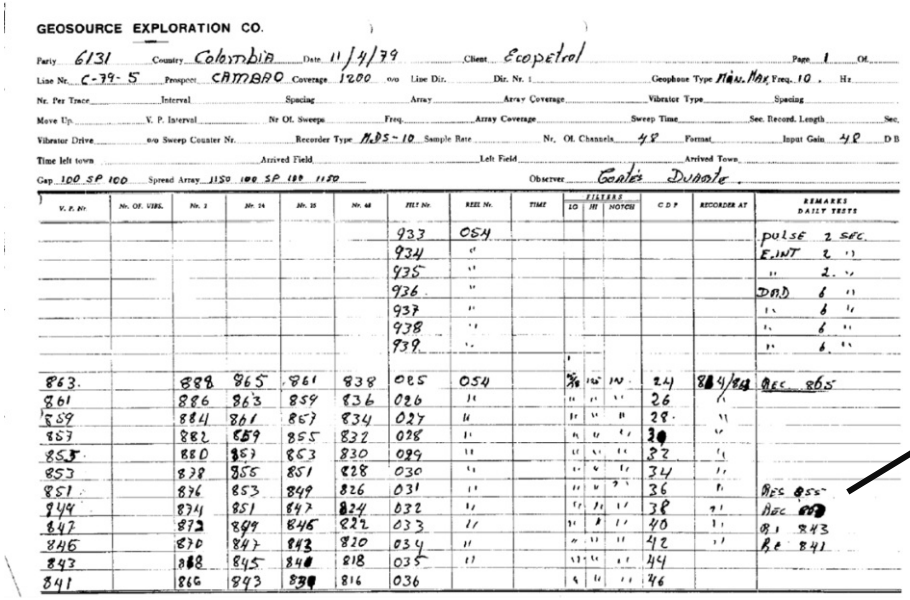
- Observer notes, Survey notes. – many errors
  - Capturing and fixing these errors very manual intensive work.

- Building geometries and Q.C by hand. New data automatic and quick.
  - Requires senior geophysicists who worked these problems 30+ years ago.
  - New geophysicists not familiar with the old methods and understanding OB's

- Sometimes difficult to attribute poor data to geometry problems or just poor data.



LMB



GEOSOURCE EXPLORATION CO.

Party 6131 Country Colombia Date 11/4/79 Client Ecopetrol Page 1 Of

Line Nr. C-79-5 Prospect CAMBAO Coverage 1200 o/o Line Dir. Dir. Nr. 1 Geophone Type Nau. Nat. Freq. 10 Hz

Nr. Per Trace Interval Spacing Array Array Coverage Vibrator Type Spacing

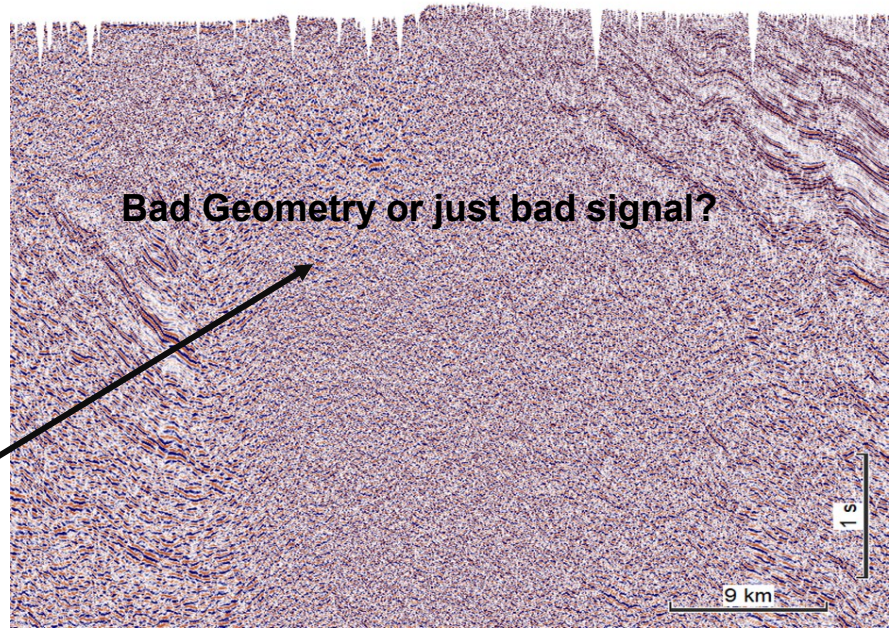
Move Up V. P. Interval Nr Of. Sweeps Freq. Array Coverage Sweep Time Sec. Record. Length Sec.

Vibrator Drive o/o Sweep Counter Nr. Recorder Type MDS-10 Sample Rate Nr. Of. Channels 48 Format Input Gain 48 D B

Time left town Arrived Field Left Field Arrived Town

Gap 100 SP 100 Spread Array 1150 100 SP 100 1150 Observer Carlos Durante

V. P. Nr.	Nr. Of. Vibs.	Nr. 2	Nr. 24	Nr. 25	Nr. 48	Field Nr.	Reel Nr.	Time	Filters LO	Filters HI	Filters Notch	C.D.P.	Recorder At	Remarks Daily Tests
						933	054							pulse 2 sec.
						934	"							E.INT 2 "
						935	"							" 2. "
						936	"							DAD 6 "
						937	"							" 6 "
						938	"							" 6 "
						939	"							" 6 "
863		888	865	861	838	025	054		3/8	16	IN	24	884/924	REC 865
861		886	863	859	836	026	"		"	"	"	26	"	
859		884	861	857	834	027	"		"	"	"	28	"	
857		882	859	855	832	028	"		"	"	"	30	"	
855		880	857	853	830	029	"		"	"	"	32	"	
853		878	855	851	828	030	"		"	"	"	34	"	
851		876	853	849	826	031	"		"	"	"	36	"	REC 855
849		874	851	847	824	032	"		"	"	"	38	"	REC 849
847		872	849	846	822	033	"		"	"	"	40	"	R.I 843
846		870	847	843	820	034	"		"	"	"	42	"	R.E 841
843		868	845	840	818	035	"		"	"	"	44		
841		866	843	838	816	036			"	"	"	46		



Problems to Resolve

Rough topography
- Statics - near surface refractors, subsurface events
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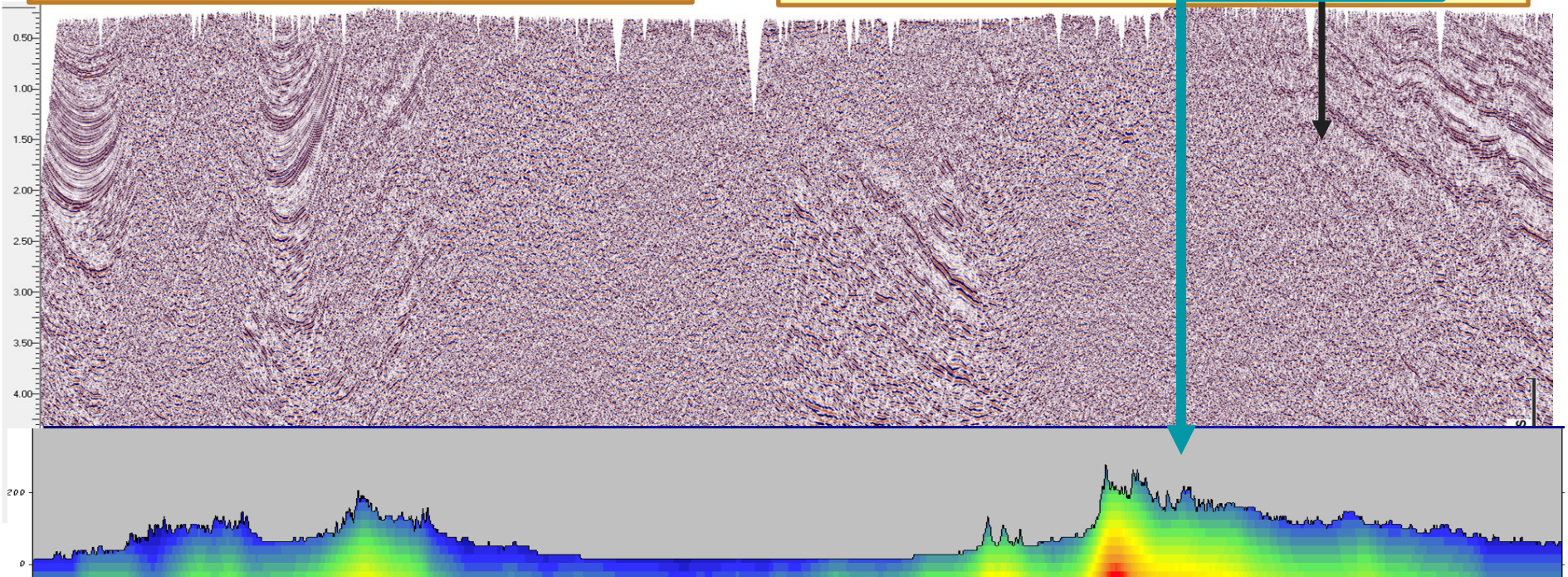
Solutions

Rigorous Near Surface Velocity Modeling
- Refraction Tomography

Depth Imaging – Velocity Model Building
- Time Migration not adequate

Limited – Industry is better but……
- Ground roll, Random

New shooting – Expensive and not feasible.



Derived Workflow – Critical Steps

Signal Processing:

- Data loading and geometry QC – logistically challenging
- *Refraction Tomography – Critical Step*
- Surface Consistent Decon and Surf Scaling
- Ground-roll Attenuation
- 3 Passes : Residual Statics + Velocity Update
- Interpolation

Solutions

Rigorous Near Surface Velocity Modeling
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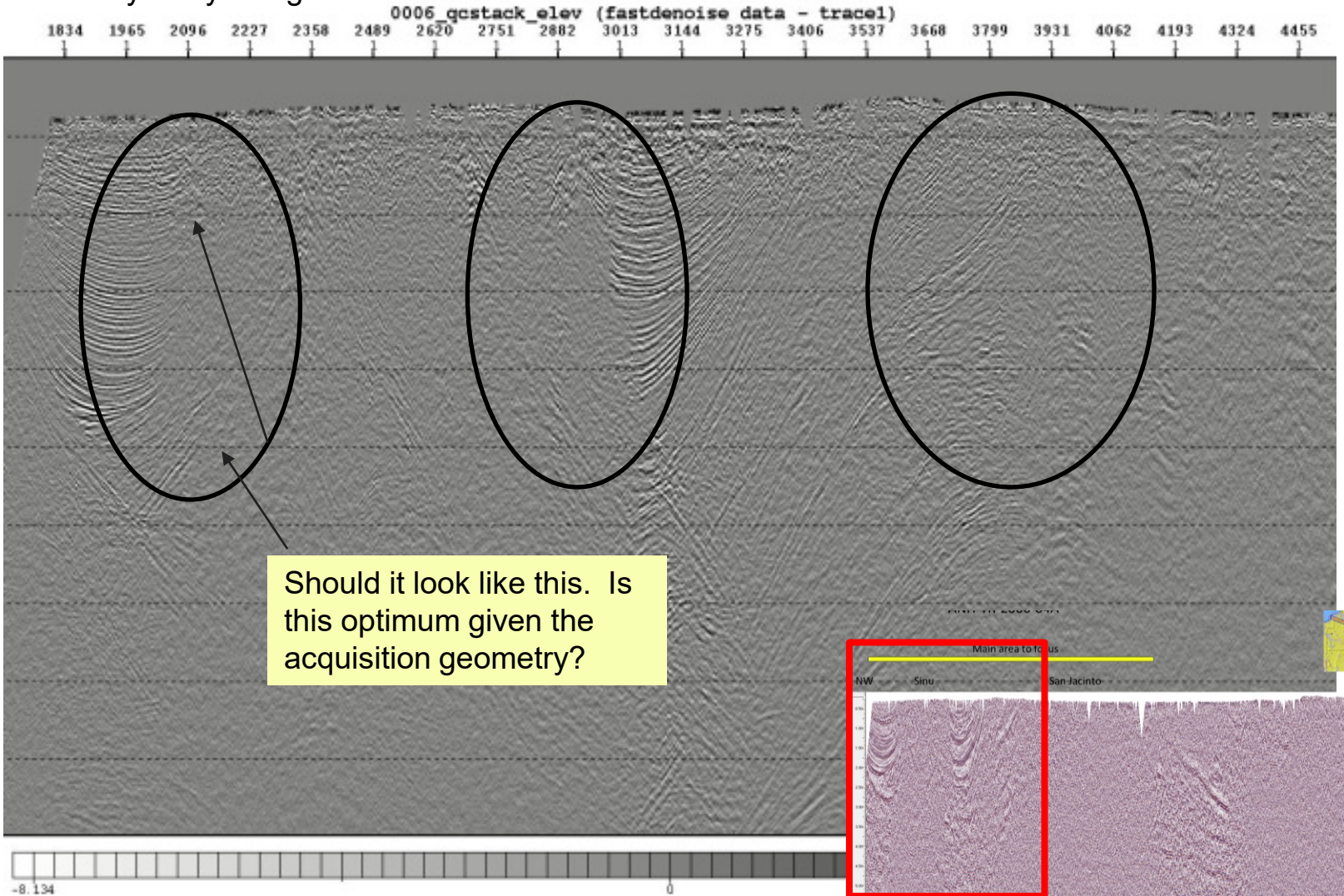
Depth Imaging

- Smooth RMS stacking velocities
- *Integrate near surface velocity into initial velocity model – critical step*
- *Iterate Isotropic depth model. 4 Iterations – critical step*
- Insert background anisotropy
- Finalize tomography velocity model
- *Merge velocity scan + tomography field – Final velocity – super critical step*
- Final Kirchhoff Migration
- Post migration enhancements
- Final PSDM stack
- RTM VMB – surface offset gathers – can have added value
- RTM VMB + Final RTM 50HZ Stack – can have added value – velocity dependent.

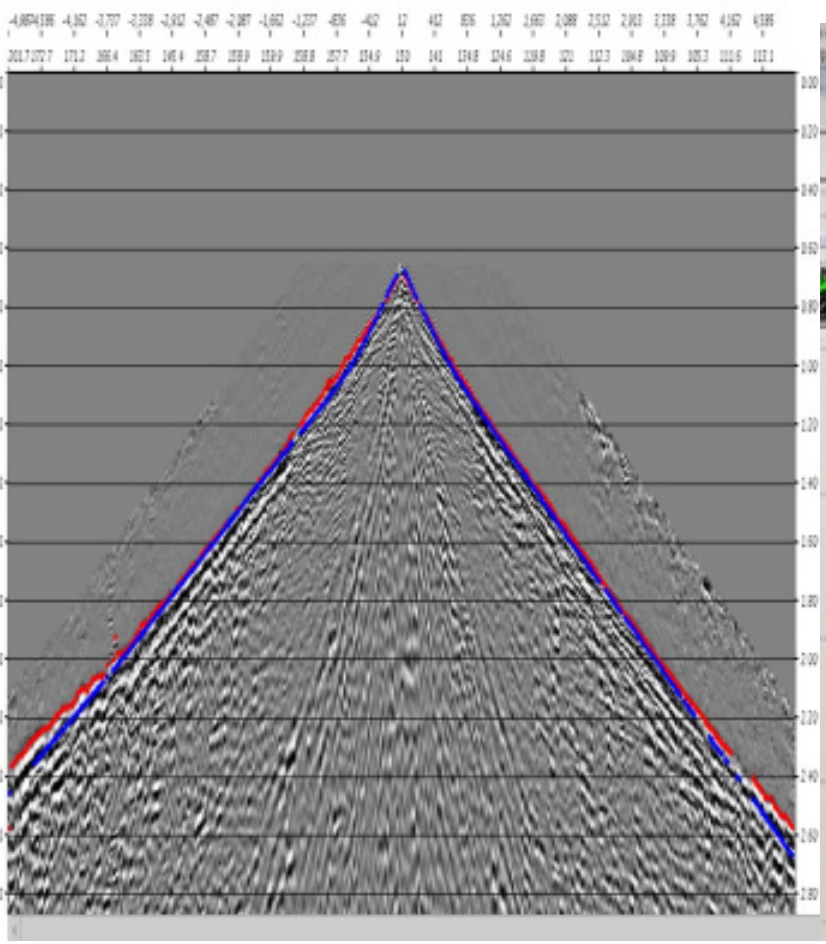
Stack with elevation statics.
Focus area.

Main challenges – resolving the velocity field.
Assumption is that the statics and geometry are solved through careful & detailed analysis by using standard methods.

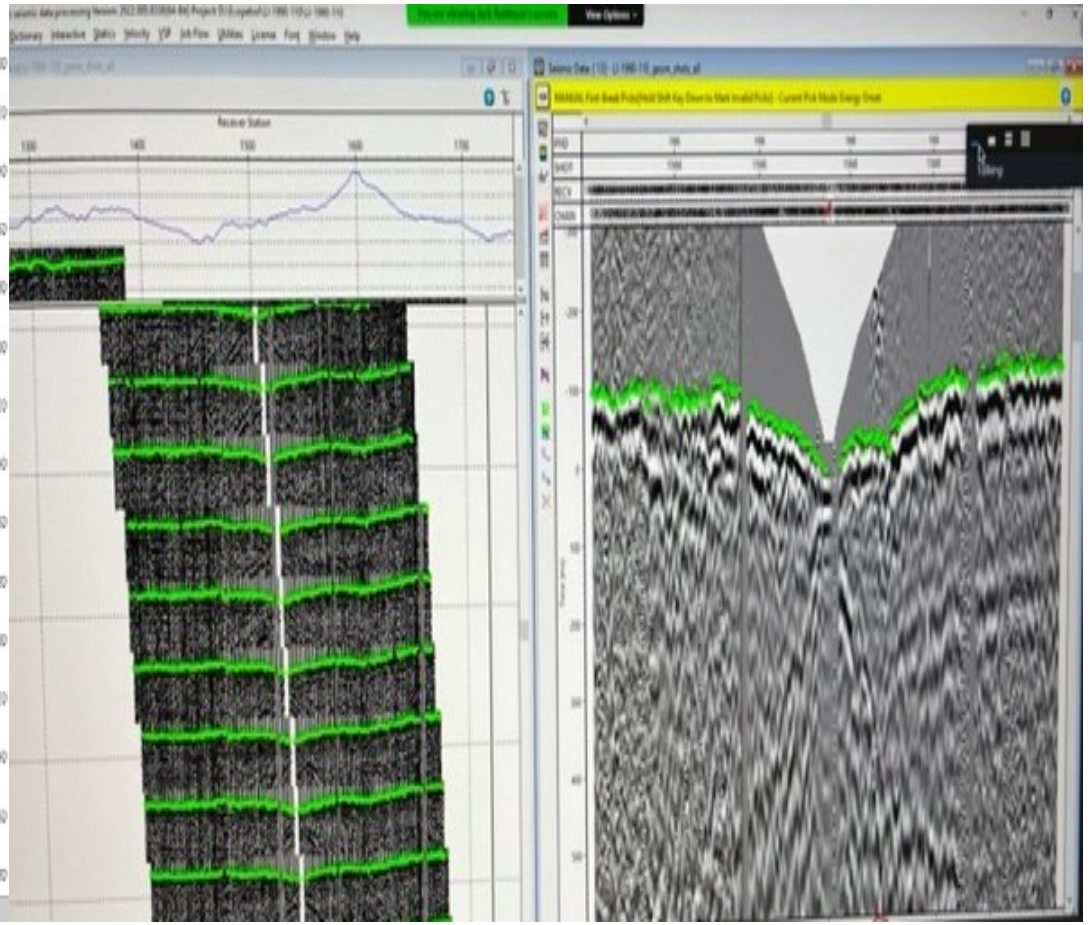


Geometry QC
Logistically challenging - manpower

Shot with 1st breaks overlay

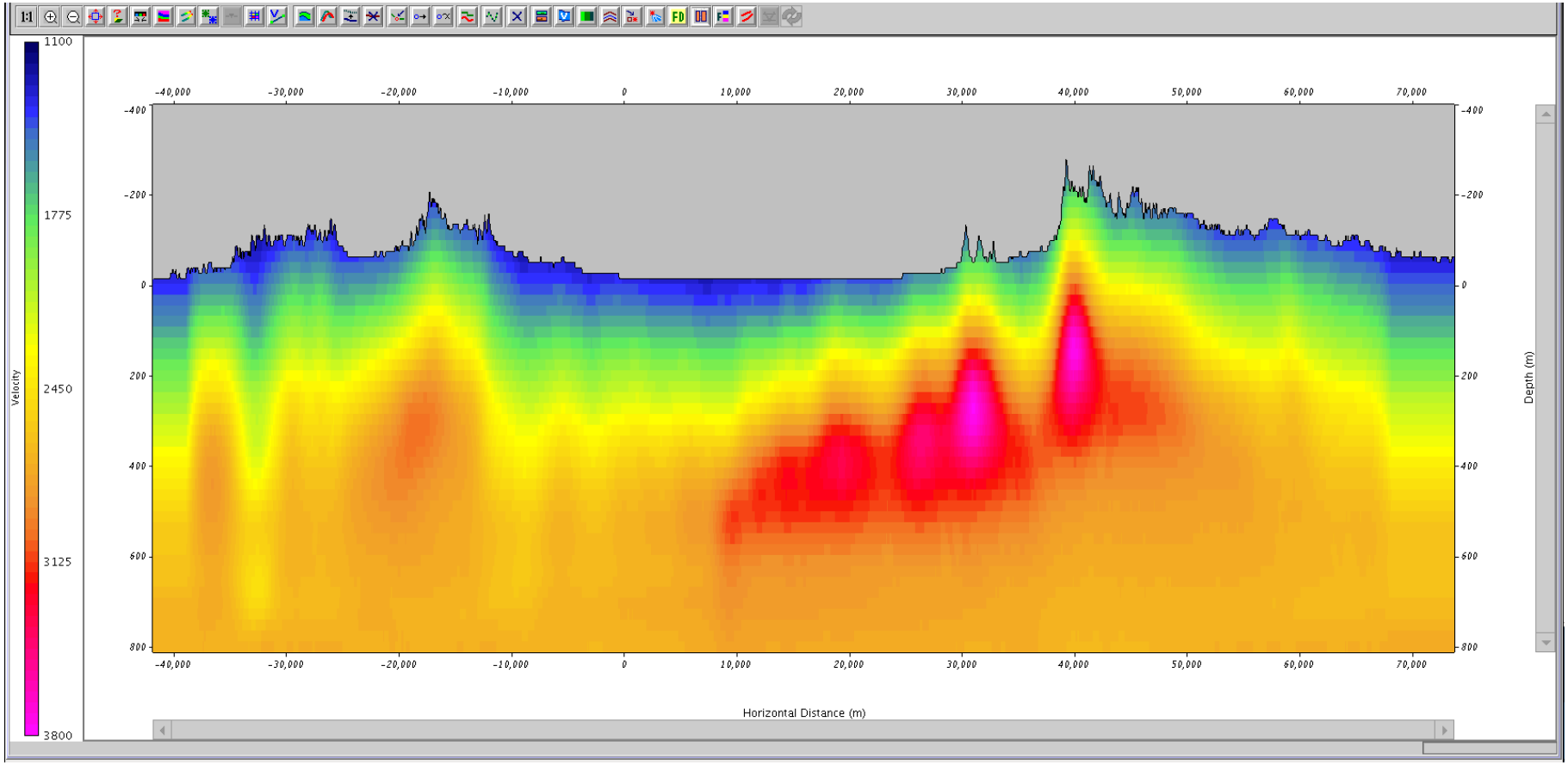


Near surface velocity corrections

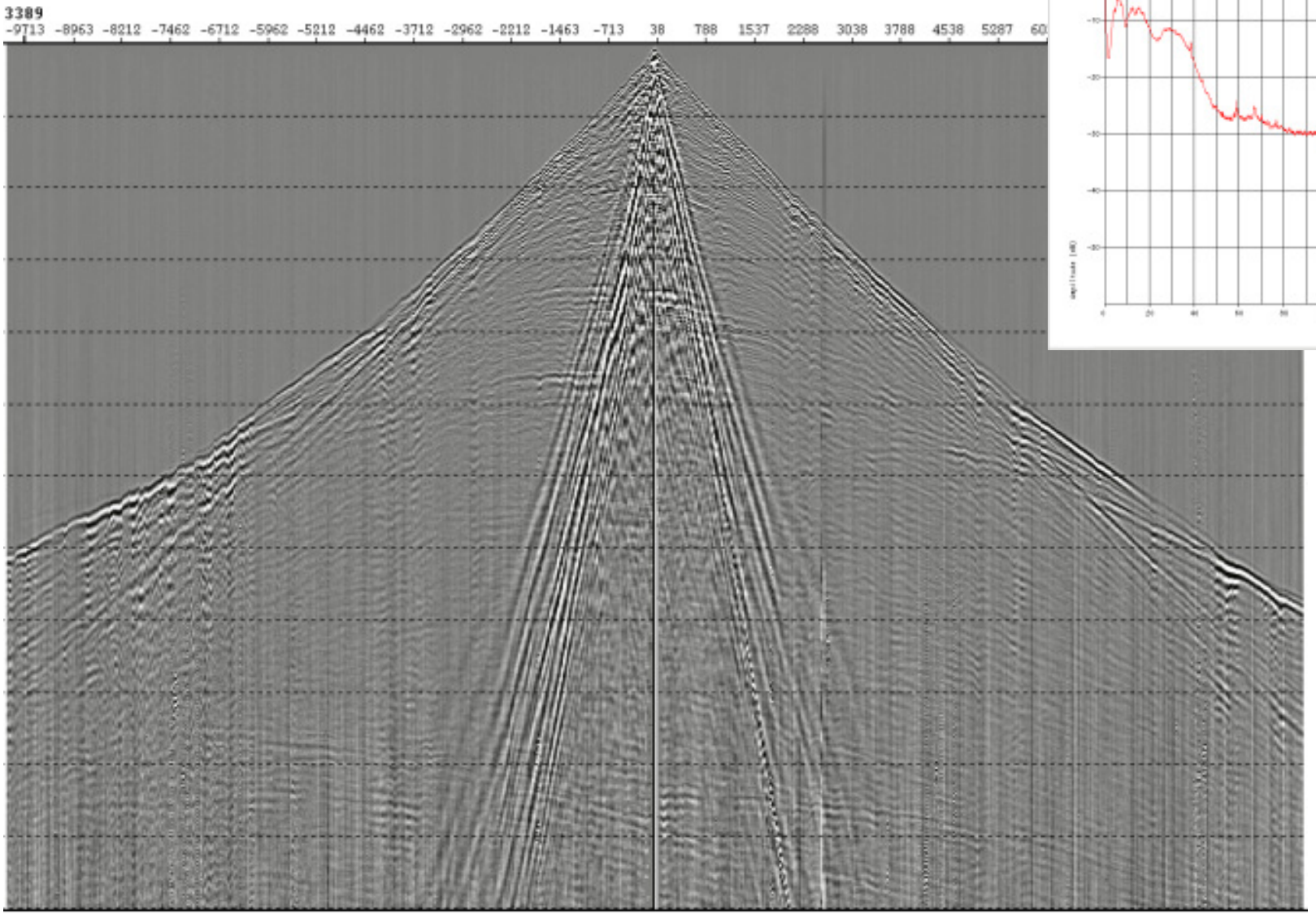


Final near surface model
Refraction Tomography

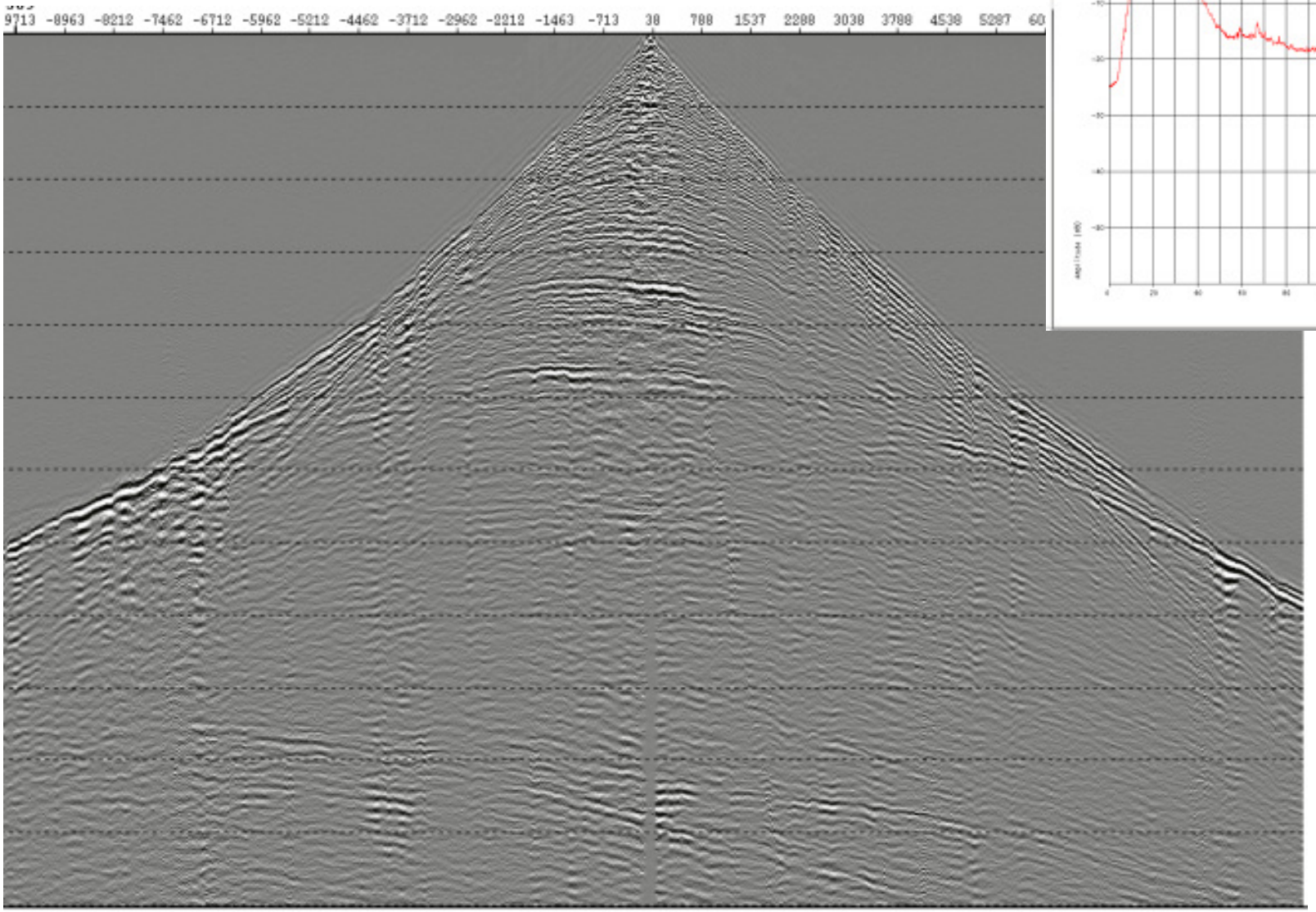
Integrate into initial velocity model of depth VMB – Critical Step



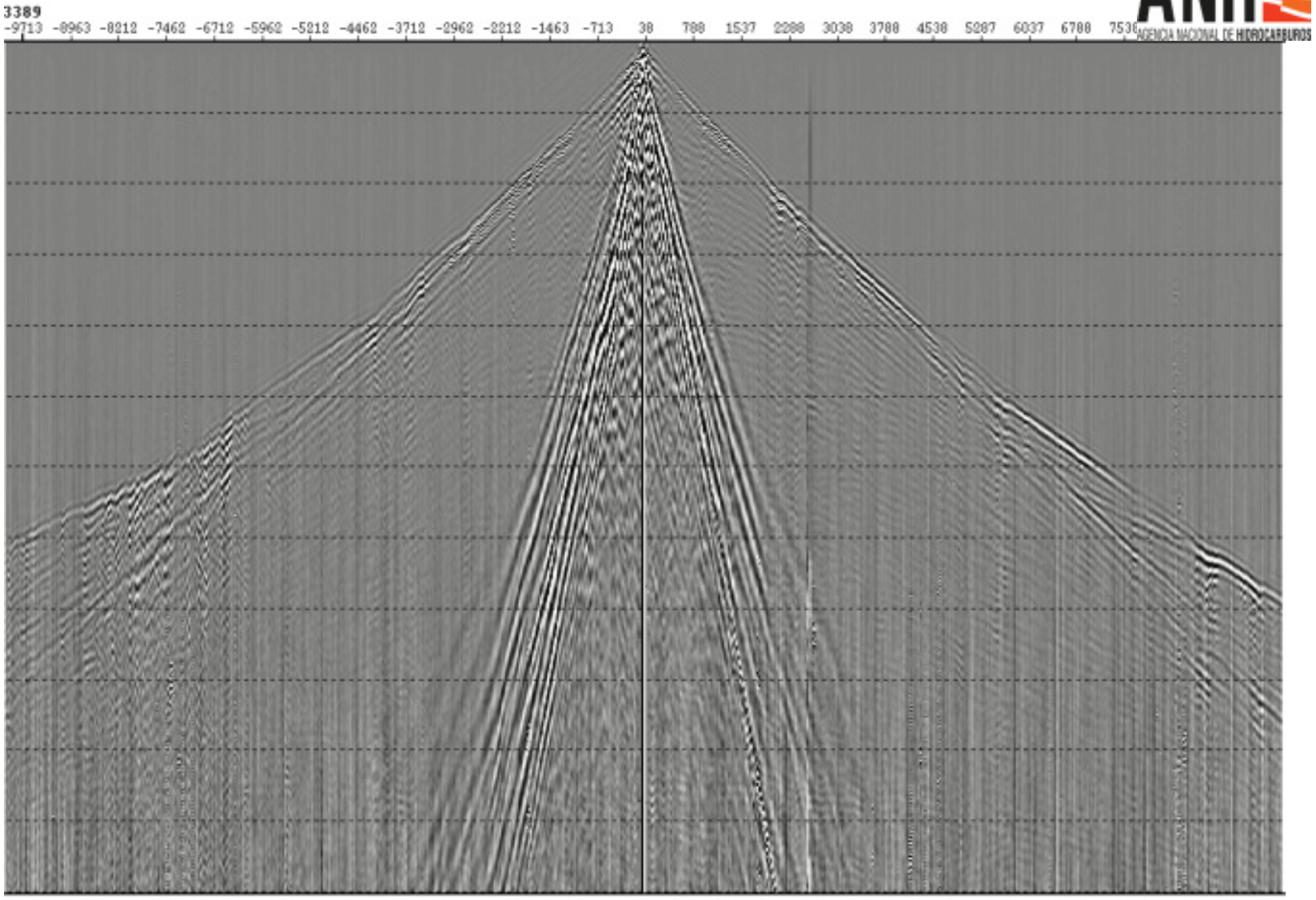
Shot before denoise



Shot after denoise
Necessary but not a differentiator



Difference
Necessary but not a differentiator

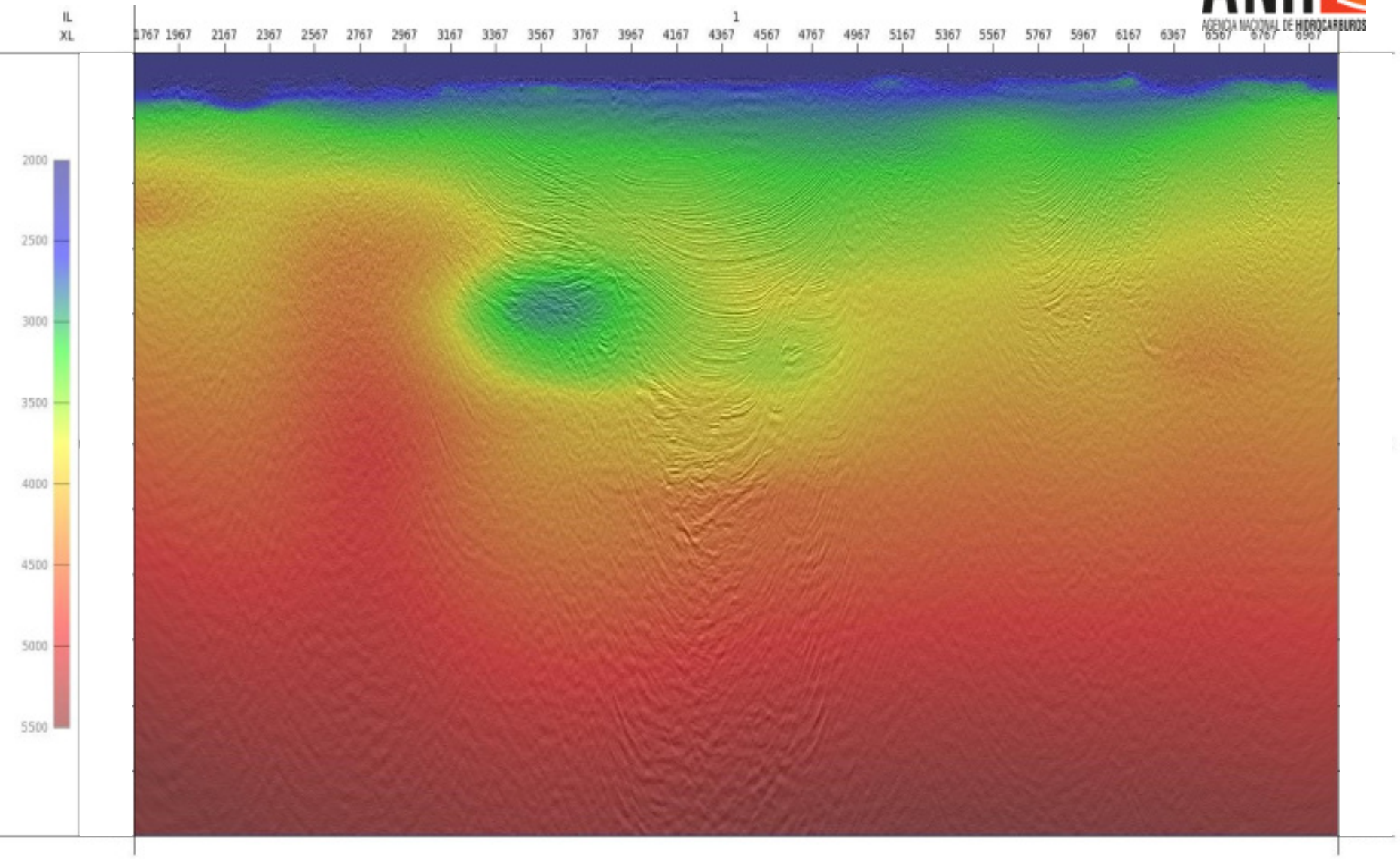


Initial Velocity Model Building

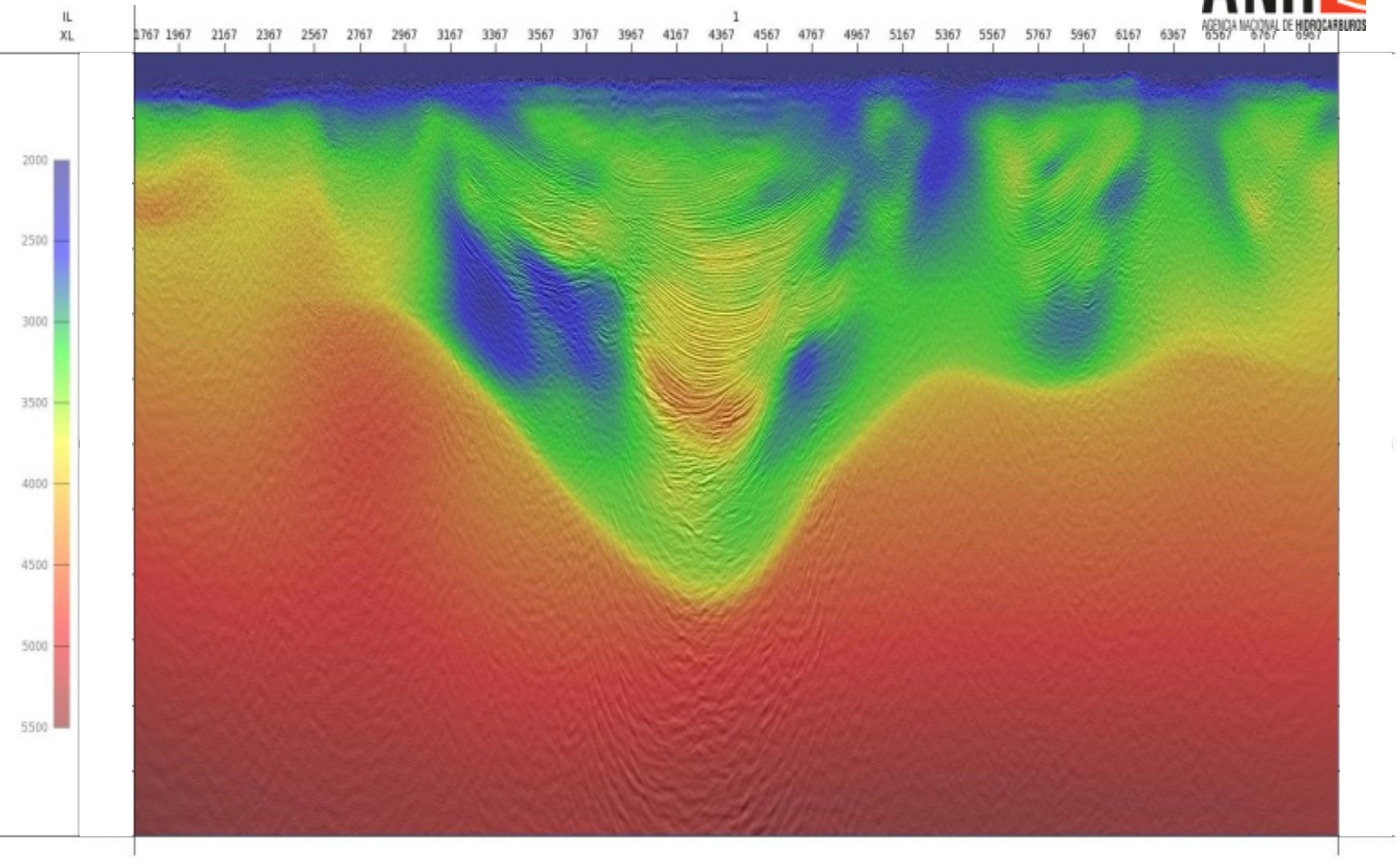
- Data
  - Import Data from final Datum
  - Remove Long-wavelength Refraction Statics – critical step
  - Shift Data from Final Datum to Floating Datum

- Initial Model
  - Convert Stacking RMS Velocity to Interval Velocity
  - Merge with Near Surface Refraction Tomography Velocity – critical step

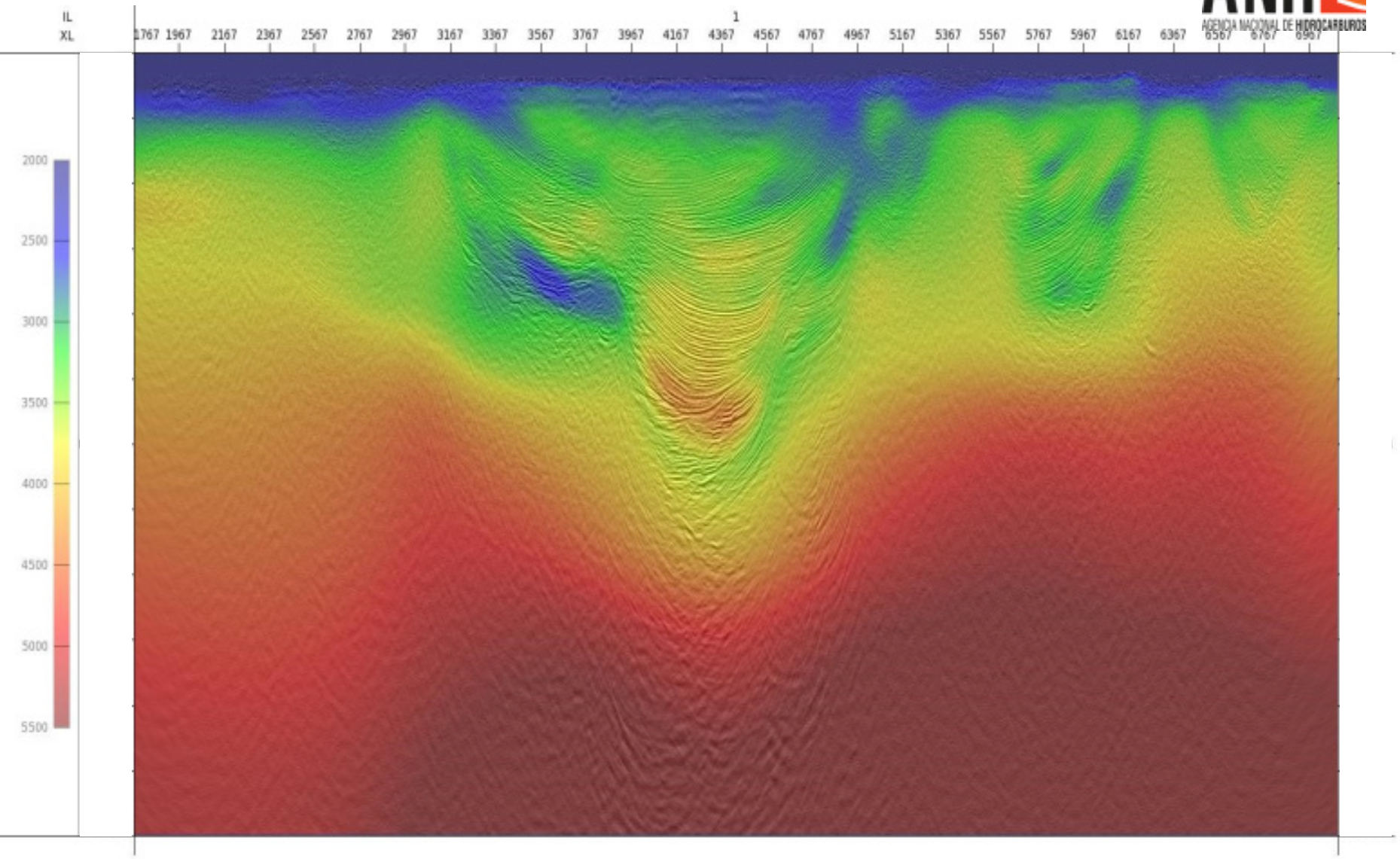
Interval Velocity - Initial



Interval Velocity – Final Tomo Vel

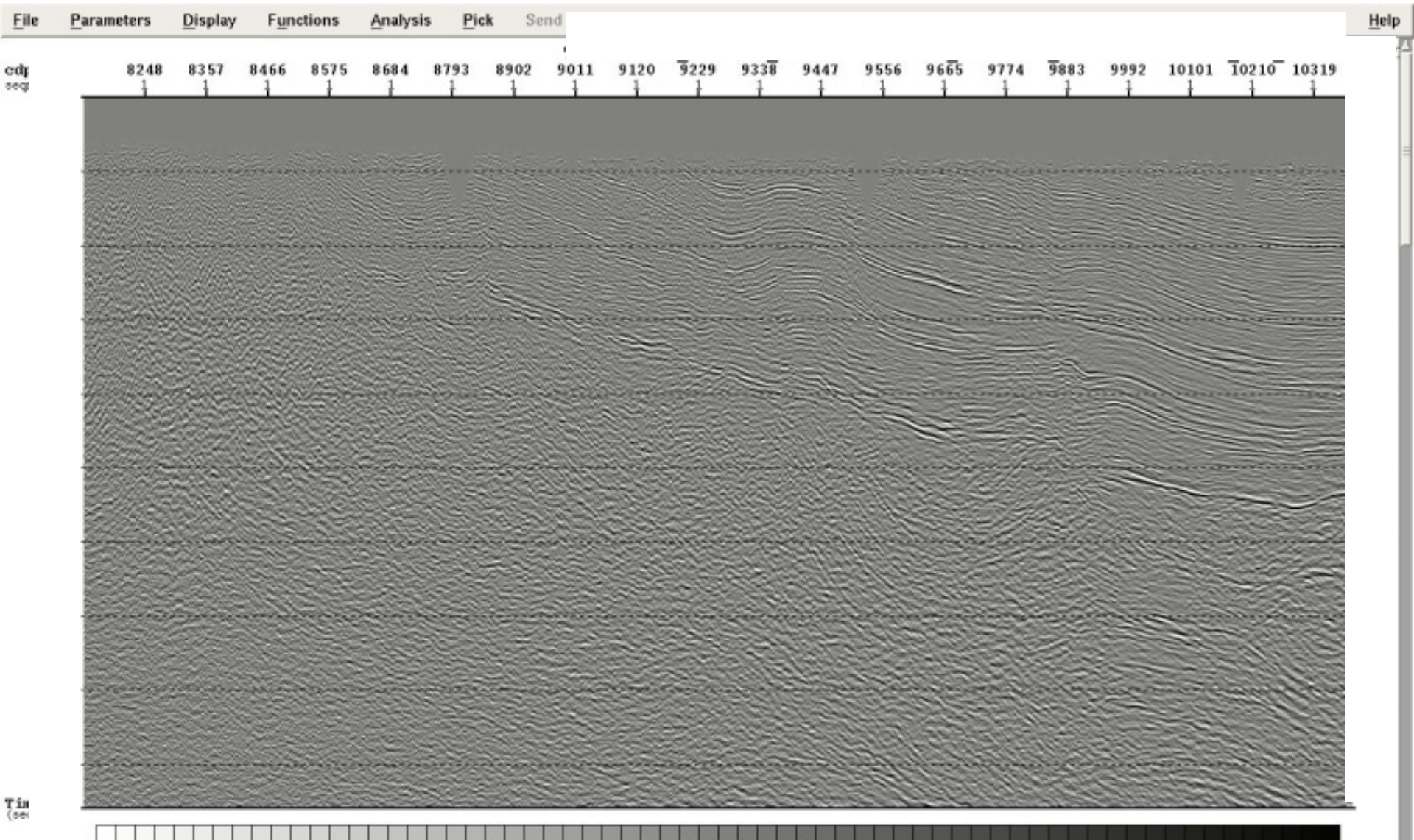


Interval Velocity – Final velocity
- Tomo5.flood.merge – derived by vel scans

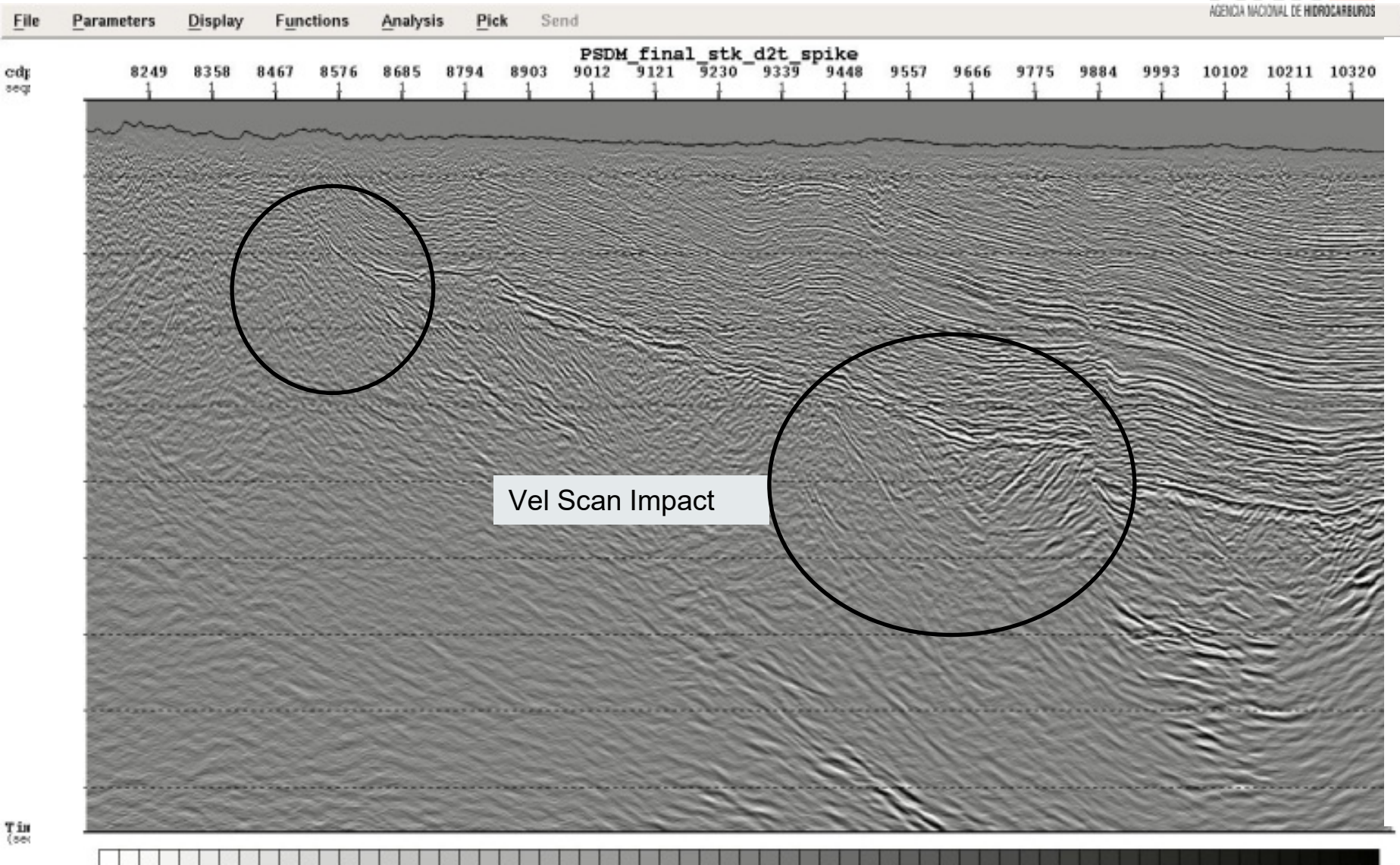


Final PSDM vs 2013 Legacy

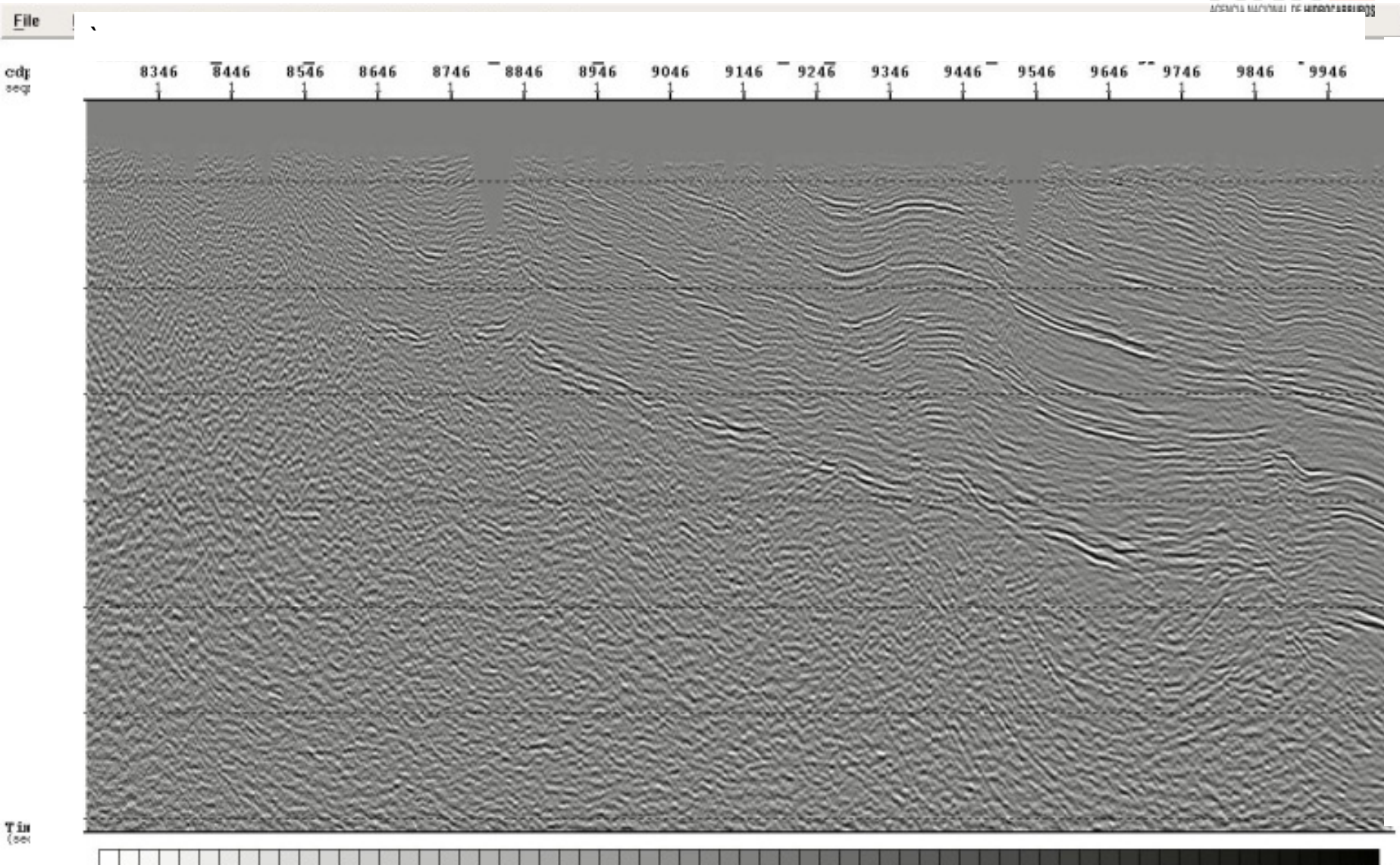
Legacy PSTM 2013



Final PSDM stack (scaled to time)



Legacy PSTM 2013



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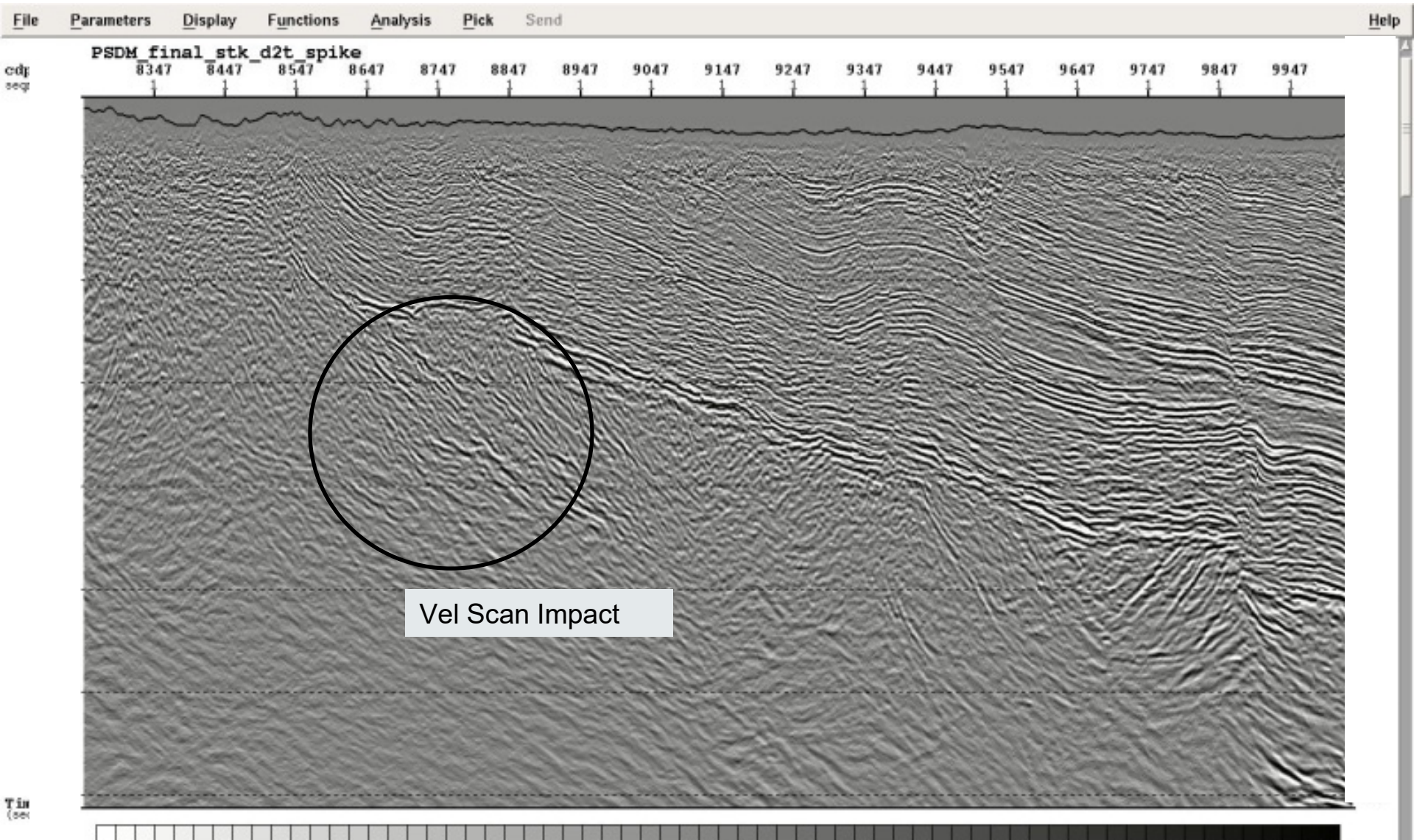
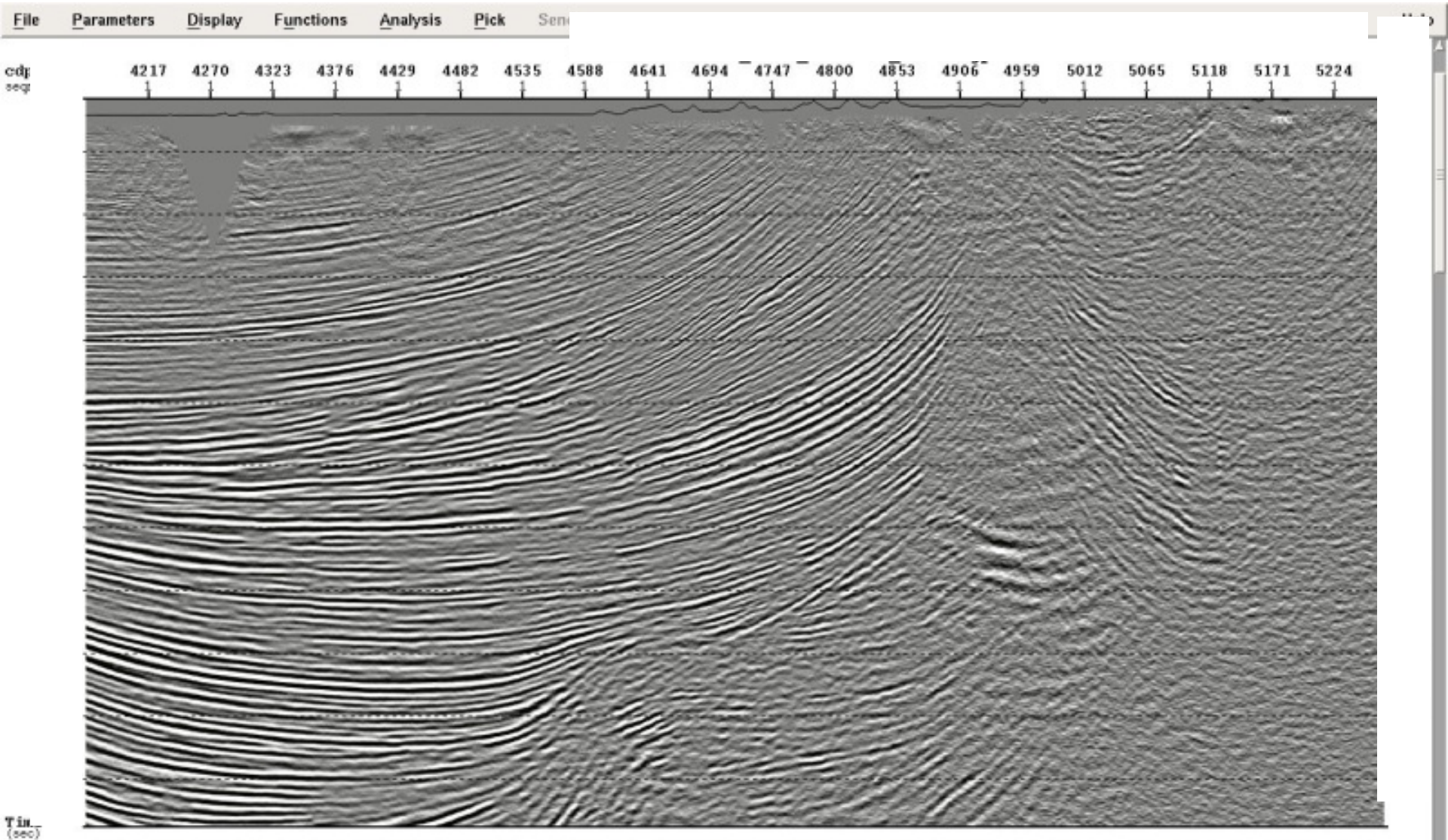


Legacy PSTM
2013



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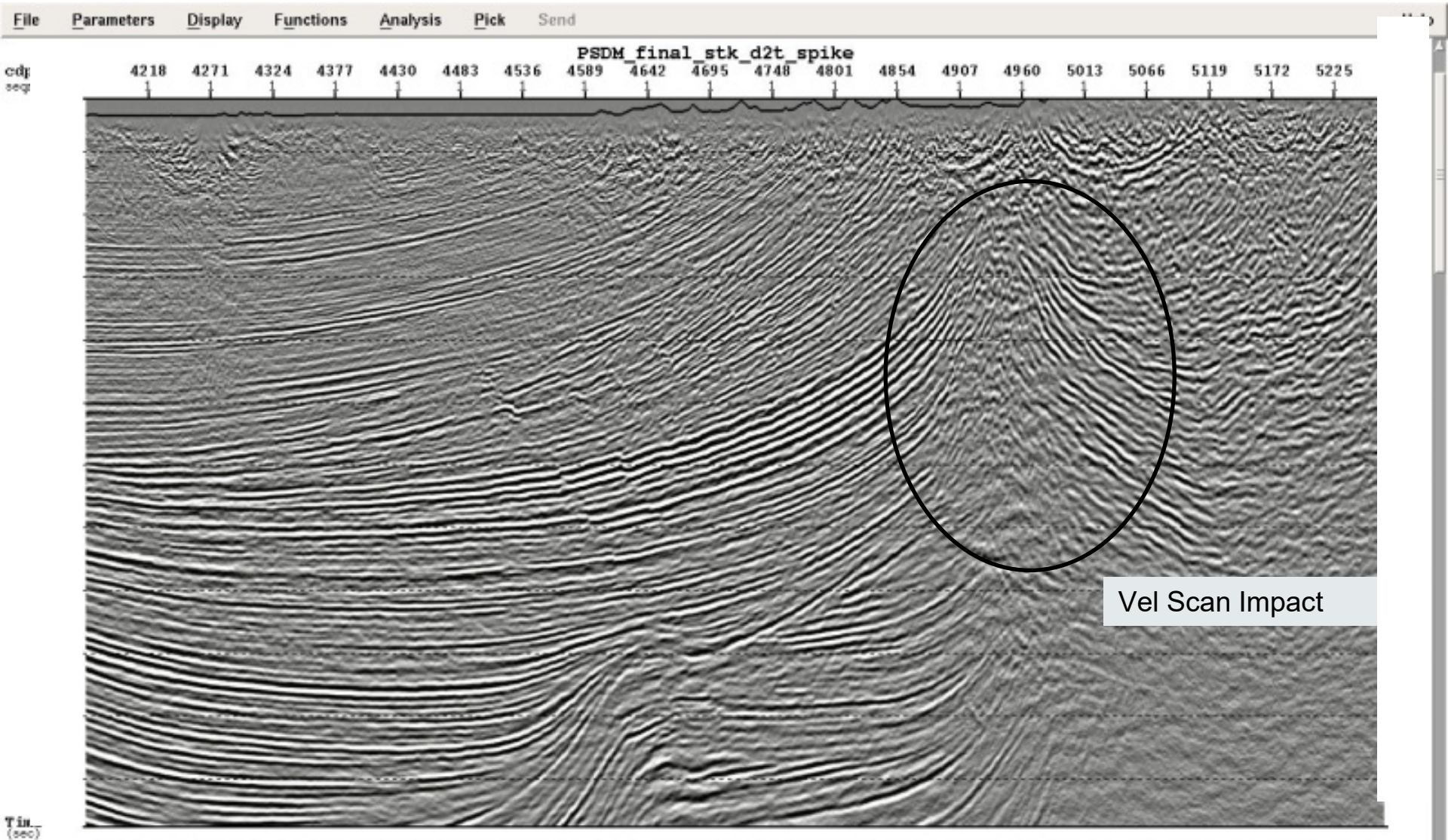

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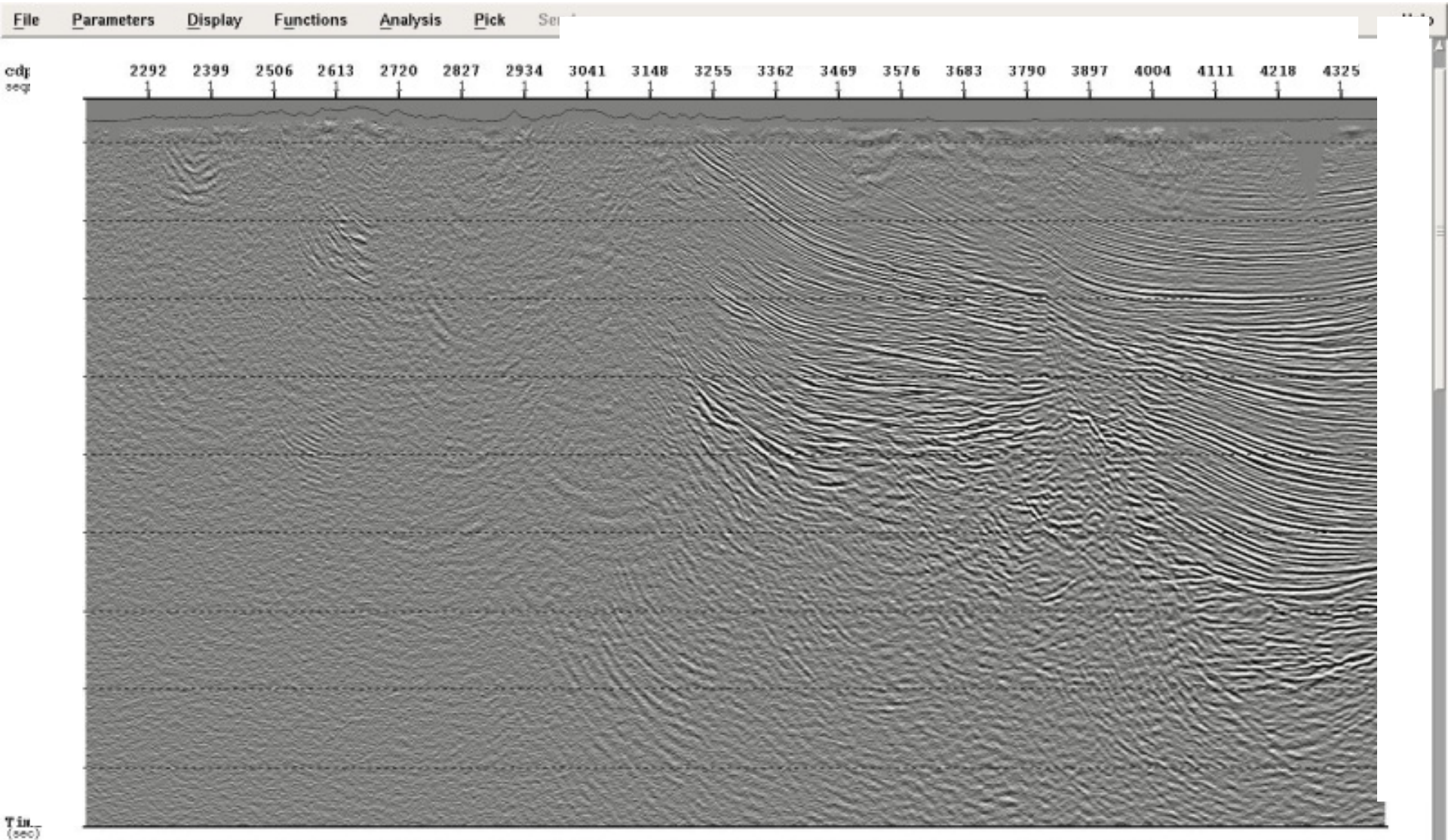

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