Schlumberger

Schlumberger Oilfield Australia Pty Limited
A.C.N. 003 264 597
Level 5, 256 St. George's Tce.
Perth WA 6000
Ph: (09) 9420 4800 Fax: (09) 9420 4715

Woodside Energy Ltd.

WELL SEISMIC PROCESSING REPORT

Checkshot

Thylacine-1

FIELD: Exploration

COUNTRY: Australia

COORDINATES: Latitude: 39 14' 27.592" S
: Longitude: 142 54' 44.169" E

DATE OF CHECKSHOT SURVEY: 23-MAY-2001

REFERENCE NO: DS 601-012

INTERVAL: 130.4 – 2707 mSRD

Prepared by:
Yuri Solovyov (Schlumberger DCS)

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1. Introduction

One vertical checkshot survey was recorded with the Dual Seismic Acquisition Tool (CSAT-B2) at the ***Thylacine-1*** well. The survey was run on 23-MAY-2000.

Processing of the data consisted of performing the checkshot processing and correction to Seismic Reference Datum (Mean Sea Level in this case). This report describes the processing, explains the parameter choices and presents the results.

2. Data Acquisition

The data were acquired in one logging run using a three component Dual Seismic Acquisition Tool (CSAT-B2). A string of 3 Air Guns with 150 cu in capacity each used as the source. The gun cluster was positioned 5 m below the SRD (Meal Sea Level). Hydrophone depth was chosen 10 m below MSL. Recording was made on the Schlumberger Maxis 500 Unit using DLIS format.

Table 1. Survey Parameters

Elevation of KB	25 M
Elevation of DF	25M
Elevation of GL	-101.4 M
Energy Source	3x150 cu in. Airgun
Source Offset	45 M
Source Depth	5.0 M below MSL
Reference Sensor	Hydrophone
Hydrophone Offset	45 M
Hydrophone Depth	10.0 M below GL
Source & Hyd. Azimuth	140 Deg.
Tool Type	Dual SAT-B2
Tool Combination	Stand Alone SM-4 geophone
De-coupled Geophones	Yes
Shaker Fitted	Yes
Number of Axis	3
Geophone Type	SM-4
Frequency Response (GAC)	3-200 Hz
Sampling Rate	1 ms.
Recording Time	3.0 sec.
Acquisition Unit	MAXIS
Recording Format	DLIS

3. Well Seismic Edit

Each shot of the raw geophone data was evaluated and edited as necessary. The hydrophone data were also evaluated for signature changes and timing shifts.

The good shots at each level were stacked, using a median stacking technique, to increase the signal to noise ratio of the data. The transit time of each trace was re-computed after stacking.

3.1 Data Quality

The overall quality of the data is good. Figure 1 is a snapshot of Z Stack Time Picked versus measured depth.

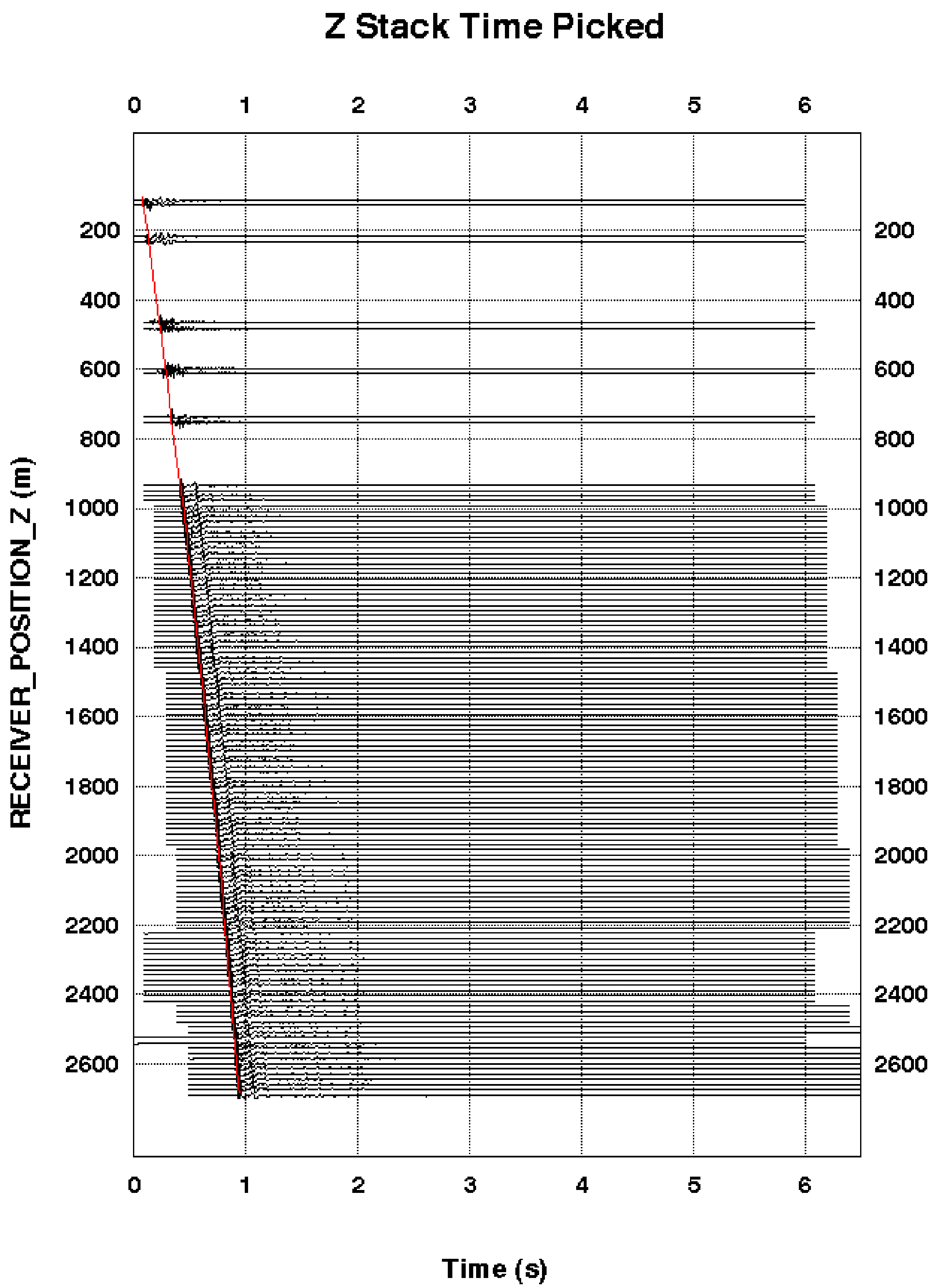


Figure 1. Z Stack Time Picked

3.2 Transit Time Measurement

The transit time measured, Delta t , corresponds to a difference between arrivals recorded by surface and downhole sensors. The reference time (zero time) is the physical recording of the source signal by accelerometers on the gun or sensors positioned near the source. In this case, a hydrophone positioned 5 m above the gun was used as the reference. First break picking algorithms were used on both the hydrophone and the geophone. Inflection Point Tangent – standard Schlumberger algorithm used for transit time picking for both geophones and hydrophone.

3.3 Correction to Datum

Seismic Reference Datum (SRD) is at Mean Sea Level.

The source was positioned 5 meters below sea surface. A hydrophone was located 5 meter below airgun 10 m below sea level. A geometry correction to SRD – Mean Sea Level was applied to all data.

4. Checkshot Processing

The vertical component of the checkshot data was processed using the conventional zero offset checkshot processing chain. The following subsections describe the main aspects of the processing chain the final data set.

- load data
- edit bad records
- Z component median stack
- peak break time

4.1 Stacking

After reordering and selecting the raw shots, a median stack was performed on the vertical component data. In this method of stacking, at each sample time, the amplitudes of the input traces are read and sorted in ascending order. The output is the median amplitude value from this ordering. If an even number of traces are input, the first is dropped and a median calculated. Then the last is dropped and another median found. The final output is the average of these two median values. The surface sensor (hydrophone) breaks are used as the zero time for stacking. The break time of each trace is recomputed after stacking. Z component stack displayed in Plot 1 with transit times picked.

5. Polarity Convention

An increase in acoustic impedance gives a positive reflection coefficient, is written to tape as a negative number and is displayed as a white trough under normal polarity. Polarity conventions are displayed in Figure2.

A Summary of Geophysical Listings

One geophysical data listings are appended to this report. Following is a brief description of the listing's format..

A1 Well Seismic Report

1. Level number: the level number starting from the top level (includes any imposed shots).

2. Vertical depth form SRD: ***dsrd***, the depth in metres from seismic reference datum.

3. Measured depth from KB: ***dkb***, the depth in metres from kelly bushing.

4. Observed travel time HYD to GEO: ***tim***0, the transit time picked form the stacked data by subtracting the surface sensor first break time from the downhole sensor first break time.

5. Vertical travel time SRD to GEO: ***shtm***, is ***timv*** corrected for the vertical distance between source and datum.

6. Delta depth between shots: ?***depth***, the vertical distance between each level.

7. Delta time between shots: ?***time***, the difference in vertical travel time (***shtm***),between each level.

8. Interval velocity between shots: the average seismic velocity between each level, ?***depth/***?***time***

9. Average velocity SRD to GEO: the average seismic velocity from datum to the corresponding checkshot level, $\frac{dsrd}{shtm}$.

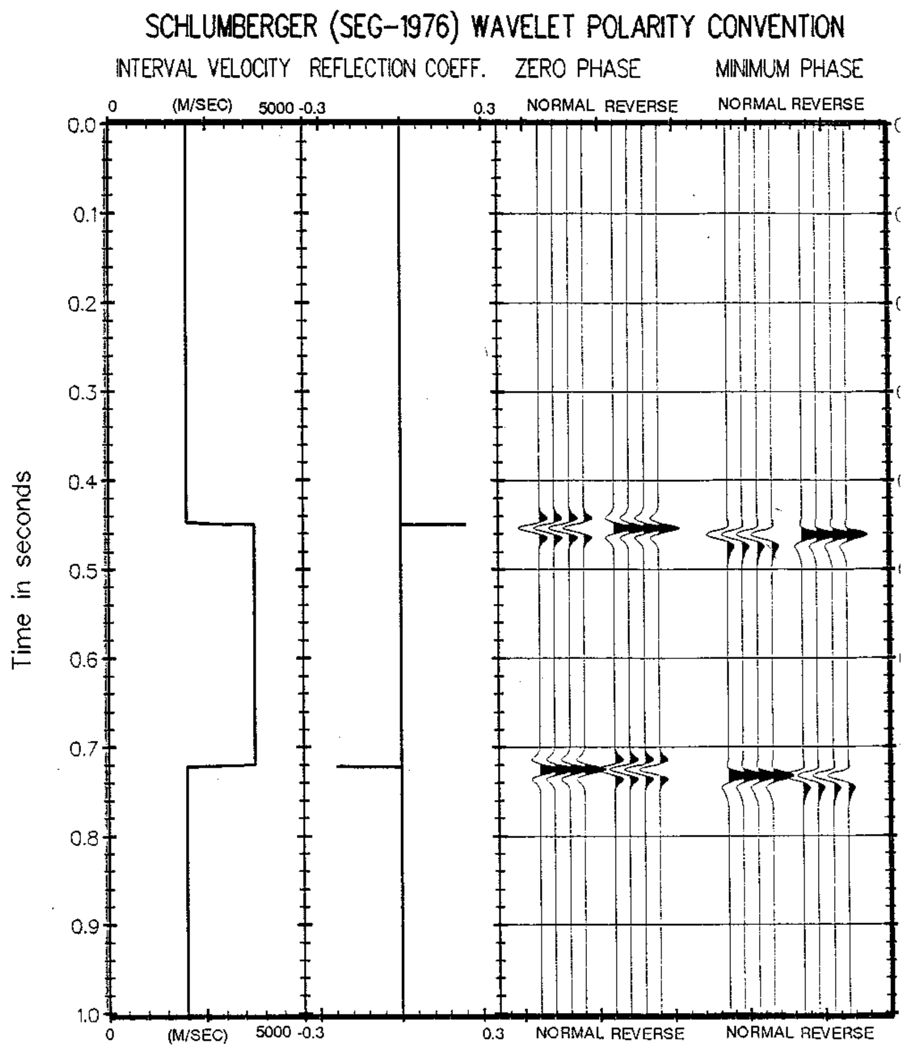


Figure 2. Schlumberger Wavelet Polarity Convention

A-1 Well Seismic Report

Client and Well Information

Country	AUSTRALIA
State	TASMANIA
Logging Date	20-May-2001
Company	
Field	EXPLORATION
Well	THYLACINE-1

Check Shot Data (Continued)

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME (owt) s	Vertical Transit Time-SRD (owt) s	DELTA DEPTH m	DELTA TIME s	SEISMIC INTERVAL VELOCITY m/s	SEISMIC AVERAGE VELOCITY m/s
1	0.0			0.0000				
							1470	
2	105.4	130.4	0.0717	0.0717				1470
					15.5	0.0084	1837	
3	120.9	145.9	0.0792	0.0802				1508
					88.9	0.0416	2135	
4	209.8	234.8	0.1181	0.1218				1723
					15.5	0.0071	2194	
5	225.3	250.3	0.1249	0.1289				1748
					234.2	0.0997	2348	
6	459.5	484.5	0.2231	0.2286				2010
					15.5	0.0058	2662	
7	475.0	500.0	0.2289	0.2344				2026
					114.5	0.0428	2675	
8	589.5	614.5	0.2715	0.2772				2127
					15.5	0.0053	2936	
9	605.0	630.0	0.2767	0.2825				2142
					124.5	0.0476	2614	
10	729.5	754.5	0.3242	0.3301				2210
					15.5	0.0066	2353	
11	745.0	770.0	0.3307	0.3367				2213
					181.6	0.0762	2384	
12	926.6	951.6	0.4068	0.4129				2244
					15.4	0.0061	2529	
13	942.0	967.0	0.4129	0.4190				2248
					14.5	0.0056	2573	
14	956.5	981.5	0.4185	0.4246				2253
					15.5	0.0058	2655	
15	972.0	997.0	0.4243	0.4304				2258
					14.5	0.0051	2840	
16	986.5	1011.5	0.4294	0.4355				2265
					15.5	0.0058	2654	

17	1002.0	1027.0	0.4353	0.4414			2270
					14.5 0.0056	2571	
18	1016.5	1041.5	0.4409	0.4470			2274
19	1032.0	1057.0	0.4471	0.4532	15.5 0.0062	2500	2277
					14.6 0.0055	2667	
20	1046.6	1071.6	0.4526	0.4587			2282
					15.4 0.0058	2677	
21	1062.0	1087.0	0.4583	0.4644			2287
					14.6 0.0056	2608	
22	1076.6	1101.6	0.4639	0.4700			2290
					15.4 0.0057	2711	
23	1092.0	1117.0	0.4696	0.4757			2295
					14.5 0.0046	3151	
24	1106.5	1131.5	0.4742	0.4803			2304
					15.5 0.0045	3478	
25	1122.0	1147.0	0.4786	0.4848			2314
					14.5 0.0044	3270	
26	1136.5	1161.5	0.4830	0.4892			2323
27	1152.0	1177.0	0.4886	0.4948	15.5 0.0055	2801	2328
					14.6 0.0055	2644	
28	1166.6	1191.6	0.4941	0.5003			2332
					15.4 0.0049	3175	
29	1182.0	1207.0	0.4989	0.5051			2340
					14.5 0.0044	3295	
30	1196.5	1221.5	0.5033	0.5095			2348
					15.5 0.0046	3356	
31	1212.0	1237.0	0.5079	0.5141			2357
					14.5 0.0050	2887	
32	1226.5	1251.5	0.5130	0.5192			2362
					15.4 0.0051	3039	
33	1241.9	1266.9	0.5180	0.5242			2369
					14.6 0.0051	2877	
34	1256.5	1281.5	0.5231	0.5293			2374
35	1272.0	1297.0	0.5280	0.5342	15.5 0.0049	3175	2381
					14.6 0.0043	3399	
36	1286.6	1311.6	0.5323	0.5385			2389
					15.4 0.0051	3014	
37	1302.0	1327.0	0.5374	0.5436			2395
					14.5 0.0045	3193	
38	1316.5	1341.5	0.5419	0.5481			2402
					15.4 0.0049	3122	
39	1331.9	1356.9	0.5468	0.5531			2408
					14.7 0.0047	3141	
40	1346.6	1371.6	0.5515	0.5578			2414
					15.4 0.0045	3448	
41	1362.0	1387.0	0.5560	0.5622			2423
					14.6 0.0044	3299	
42	1376.6	1401.6	0.5604	0.5666			2429
43	1392.0	1417.0	0.5650	0.5713	15.4 0.0046	3328	2437
					14.6 0.0048	3062	
44	1406.6	1431.6	0.5698	0.5760			2442
					15.4 0.0047	3242	
45	1422.0	1447.0	0.5745	0.5808			2448

					14.6	0.0045	3226	
46	1436.6	1461.6	0.5790	0.5853				2454
					15.4	0.0043	3585	
47	1452.0	1477.0	0.5833	0.5896	14.5	0.0054	2702	2463
48	1466.5	1491.5	0.5887	0.5950				2465
					15.5	0.0052	3008	
49	1482.0	1507.0	0.5938	0.6001				2469
					14.5	0.0044	3293	
50	1496.5	1521.5	0.5982	0.6045				2475
					15.5	0.0052	2955	
51	1512.0	1537.0	0.6035	0.6098				2480
					14.6	0.0043	3392	
52	1526.6	1551.6	0.6078	0.6141				2486
					15.4	0.0045	3409	
53	1542.0	1567.0	0.6123	0.6186				2493
					14.5	0.0046	3150	
54	1556.5	1581.5	0.6169	0.6232				2498
					15.5	0.0049	3187	
55	1572.0	1597.0	0.6218	0.6281	14.5	0.0043	3393	2503
56	1586.5	1611.5	0.6260	0.6323				2509
					15.5	0.0044	3499	
57	1602.0	1627.0	0.6305	0.6368				2516
					14.5	0.0046	3172	
58	1616.5	1641.5	0.6350	0.6413				2521
					15.5	0.0044	3534	
59	1632.0	1657.0	0.6394	0.6457				2527
					14.5	0.0043	3366	
60	1646.5	1671.5	0.6437	0.6500				2533
					15.5	0.0045	3440	
61	1662.0	1687.0	0.6482	0.6545				2539
					14.6	0.0043	3363	
62	1676.6	1701.6	0.6526	0.6589				2545
					15.4	0.0043	3599	
63	1692.0	1717.0	0.6568	0.6632	14.5	0.0043	3408	2551
64	1706.5	1731.5	0.6611	0.6674				2557
					15.5	0.0043	3584	
65	1722.0	1747.0	0.6654	0.6717				2563
					14.5	0.0049	2975	
66	1736.5	1761.5	0.6703	0.6766				2566
					15.5	0.0047	3286	
67	1752.0	1777.0	0.6750	0.6813				2571
					14.5	0.0047	3055	
68	1766.5	1791.5	0.6797	0.6861				2575
					15.5	0.0049	3137	
69	1782.0	1807.0	0.6847	0.6910				2579
					14.6	0.0044	3290	
70	1796.6	1821.6	0.6891	0.6955				2583
					15.4	0.0053	2922	
71	1812.0	1837.0	0.6944	0.7007	14.5	0.0051	2866	2586
72	1826.5	1851.5	0.6994	0.7058				2588
					15.5	0.0045	3445	
73	1842.0	1867.0	0.7039	0.7103				2593
					14.5	0.0047	3091	

74	1856.5	1881.5	0.7086	0.7150			2597
					15.4 0.0050	3108	
75	1871.9	1896.9	0.7136	0.7199			2600
76	1886.5	1911.5	0.7175	0.7239	14.6 0.0039	3706	2606
					15.4 0.0047	3243	
77	1901.9	1926.9	0.7223	0.7286			2610
					14.6 0.0046	3172	
78	1916.5	1941.5	0.7269	0.7332			2614
					15.5 0.0046	3396	
79	1932.0	1957.0	0.7314	0.7378			2619
					14.5 0.0043	3384	
80	1946.5	1971.5	0.7357	0.7421			2623
					15.4 0.0044	3515	
81	1961.9	1986.9	0.7401	0.7465			2628
					14.6 0.0044	3341	
82	1976.5	2001.5	0.7445	0.7508			2632
					15.5 0.0041	3742	
83	1992.0	2017.0	0.7486	0.7550			2639
84	2006.5	2031.5	0.7525	0.7589	14.5 0.0039	3702	2644
					15.4 0.0043	3617	
85	2021.9	2046.9	0.7568	0.7631			2649
					14.7 0.0042	3459	
86	2036.6	2061.6	0.7610	0.7674			2654
					15.4 0.0040	3808	
87	2052.0	2077.0	0.7651	0.7714			2660
					14.5 0.0038	3826	
88	2066.5	2091.5	0.7688	0.7752			2666
					15.5 0.0041	3757	
89	2082.0	2107.0	0.7730	0.7793			2671
					14.5 0.0039	3746	
90	2096.5	2121.5	0.7768	0.7832			2677
					15.5 0.0039	3941	
91	2112.0	2137.0	0.7808	0.7872			2683
92	2126.5	2151.5	0.7850	0.7914	14.5 0.0042	3440	2687
					15.5 0.0042	3657	
93	2142.0	2167.0	0.7892	0.7956			2692
					14.5 0.0036	4032	
94	2156.5	2181.5	0.7928	0.7992			2698
					15.4 0.0042	3690	
95	2171.9	2196.9	0.7970	0.8034			2703
					14.6 0.0040	3670	
96	2186.5	2211.5	0.8010	0.8074			2708
					15.4 0.0037	4112	
97	2201.9	2226.9	0.8047	0.8111			2715
					14.6 0.0046	3152	
98	2216.5	2241.5	0.8093	0.8157			2717
					15.4 0.0037	4147	
99	2231.9	2256.9	0.8131	0.8194			2724
100	2246.5	2271.5	0.8167	0.8231	14.6 0.0037	3975	2729
					15.5 0.0043	3639	
101	2262.0	2287.0	0.8210	0.8274			2734
					14.5 0.0039	3706	
102	2276.5	2301.5	0.8249	0.8313			2739

					15.5 0.0045	3477	
103	2292.0	2317.0	0.8293	0.8357			2742
					14.5 0.0040	3652	
104	2306.5	2331.5	0.8333	0.8397	15.5 0.0038	4077	2747
105	2322.0	2347.0	0.8371	0.8435			2753
					14.5 0.0039	3733	
106	2336.5	2361.5	0.8410	0.8474			2757
					15.5 0.0035	4368	
107	2352.0	2377.0	0.8445	0.8510			2764
					14.5 0.0044	3324	
108	2366.5	2391.5	0.8489	0.8553			2767
					15.5 0.0038	4096	
109	2382.0	2407.0	0.8527	0.8591			2773
					14.6 0.0033	4486	
110	2396.6	2421.6	0.8559	0.8624			2779
					15.4 0.0044	3514	
111	2412.0	2437.0	0.8603	0.8667			2783
					14.6 0.0038	3799	
112	2426.6	2451.6	0.8642	0.8706	15.4 0.0038	4103	2787
113	2442.0	2467.0	0.8679	0.8743			2793
					14.5 0.0038	3767	
114	2456.5	2481.5	0.8718	0.8782			2797
					15.5 0.0035	4459	
115	2472.0	2497.0	0.8752	0.8817			2804
					14.5 0.0043	3353	
116	2486.5	2511.5	0.8796	0.8860			2806
					15.5 0.0033	4712	
117	2502.0	2527.0	0.8829	0.8893			2814
					14.5 0.0038	3785	
118	2516.5	2541.5	0.8867	0.8931			2818
					15.4 0.0034	4483	
119	2531.9	2556.9	0.8901	0.8965			2824
					14.6 0.0042	3465	
120	2546.5	2571.5	0.8943	0.9008	15.5 0.0037	4192	2827
121	2562.0	2587.0	0.8980	0.9044			2833
					14.5 0.0044	3332	
122	2576.5	2601.5	0.9024	0.9088			2835
					15.4 0.0034	4574	
123	2591.9	2616.9	0.9057	0.9122			2841
					14.6 0.0039	3763	
124	2606.5	2631.5	0.9096	0.9160			2845
					15.4 0.0035	4444	
125	2621.9	2646.9	0.9131	0.9195			2851
					14.6 0.0042	3441	
126	2636.5	2661.5	0.9173	0.9238			2854
					15.4 0.0038	4074	
127	2651.9	2676.9	0.9211	0.9275			2859
					14.6 0.0045	3265	
128	2666.5	2691.5	0.9256	0.9320	15.5 0.0029	5262	2861
129	2682.0	2707.0	0.9285	0.9350			2869

Attachment 1. Transit Time Picking Algorithms

The time picking can be broken down into several tasks:

First of all focus on the relevant parts of a data trace by selecting time intervals in form of constraints. To this end the user can select velocity, time header and/or initial guess constraints.

Detect a signal or a first break using a detection algorithm.

Tune on a particular phase of the event (e.g. zero-crossing, peak, trough, etc). It should be clear that tuning is only happening if a pick was either detected by an algorithm or retrieved from a header as initial guess.

Despike the picked transit time curve in order to eliminate mispicks either by median filtering or by cross-correlation. The cross-correlation option does not only have filtering features but also allows to pick correlated events within a section after having picked only one event.

Detection algorithm

Energy break: the algorithm determines the maximum of the so-called energy function, which is the integrated signal energy within a sliding time window normalized by the total energy accumulated since the first time of data.

For a trace S(t) an energy function F(?) is calculated with algorithm proposed by (Coppens, 1985)

Geophone break: finds the first break of a downhole sensor. The algorithm compares amplitudes and slopes in consecutive arches. Input parameters are the center frequency of the data to be picked, a linear fit gate time which should be about half a wavelet period, and a detection threshold between 0.0 and 0.5.

Hydrophone break: provides the first break of a downhole sensor. The routine finds the global minimum and maximum amplitude along a trace, takes the smaller one of the corresponding sample indices and outputs the time of the preceding zero-crossing as the first break. The zero-crossing time is determined by linear regression over a selected length (linear fit gate time).

Tuning:

Peak: finds the time of the closest local maximum amplitude in the vicinity of an input break time.

Trough: finds the time of closest local minimum amplitude in the vicinity of an input break time.

Zero-crossing: finds the time of the closest zero-crossing in the vicinity of an input break time. The routine stores the sign of the derivative at the zero-crossing which can be passed on for the tuning of the following trace. Thus artifacts created by cycle skipping can be reduced.

Inflection: finds the time of the closest inflection point in the vicinity of an input break time. The routine stores the sign of the derivative at the inflection point which can be passed on for the tuning of the following trace. Thus artifacts created by cycle skipping can be reduced.

Inflection point tangent: finds the time of the closest inflection point in the vicinity of an input break time. The tuned break time is the zero-crossing time of the corresponding tangent at this inflection point. The routine stores the sign of the derivative at the inflection point which can be passed on for the tuning of the following trace. Thus artifacts created by cycle skipping can be reduced.

Cross-correlation

This option allows to tune transit times by considering the picked phase of a selected reference trace. The cross-correlation gate in time or length units can be specified in the Motif parameter panel of this option. The default value for the gate is three times the estimated center frequency of the first five traces of the seismic section to be picked. The window is put symmetrically around the transit times of the two traces to be cross-correlated if the option Use Existing Picks for the Gate Center Time is enabled and the transit times are not absent.

If the option Use Existing Picks for the Gate Center Time is disabled then the cross-correlation is started with the ambient traces around the reference trace. Those two traces, in turn, will be taken to set the time gates for the following ones, and so on. Thus an automatic picking can be provided after having picked only the reference trace.

Retuning can be selected to follow the cross-correlation. In this case the cross-correlation serves as a transit time curve despiker.

The cross correlation process can be stopped automatically if the picking quality degrades. This happens if the time difference between the break of the current and the previous trace exceeds a threshold value derived from a user-specified apparent velocity.

A polynomial amplitude interpolation is proposed in order provide “real” extreme values instead of extreme values at the nearest sample. The algorithm works as follows: the global extreme values are detected with the gate together with the corresponding sample indices. A minimum and maximum amplitude tuning provides an exact time estimate of these amplitudes. Polynomial interpolation determines the amplitudes at these times which generally fall in between samples.

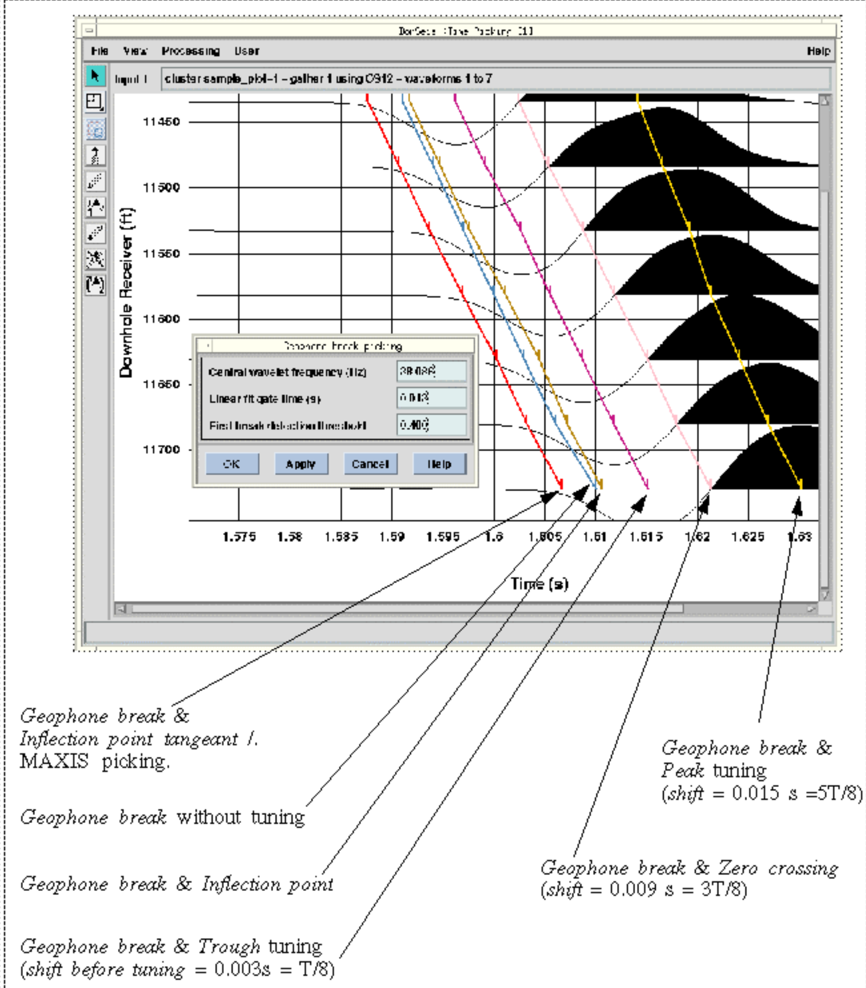
There are a variety of selectable and non-exclusive constraints available in order to stabilize the time picking process . The objective is to extract only the relevant part of the trace for the detection, tuning and/or cross-correlation process using.

Reference:

Coppens, F., 1985, First arrival picking on common offset trace collections for automatic estimation of static corrections, Geophys. Prosp. 33, 1212-1231.

Lee, D. and Morf, M., 1980, A novel innovations based time –domain pitch detection.

Example:



Note: the period of the signal (T) is computed from the central frequency.
the default linear fit gate time =T/2.

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