Salton Sea Modeling Journal

Beginning Jan-08-2015

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Contents

Thursday, 8 January 2015

1 Modeling varying interfaces for the SSAF

Try various surface expressions of the high-velocity interface to investigate how well-constrained this is, and if the interface is more likely to be to the East or West of the SSAF surface trace. This will aid in determining what fault structure is present; if the fault is to the west of the surface trace of the SSAF, it is more likely a normal fault in the Salton Sea, not visible on land. If it intersects the surface trace, it is likely that the fault may have a westward dip/oblique component; if to the east, there may be a larger normal fault cross-cutting the modern-day SSAF.

To modify the starting model and adjust the interface's surface trace, use the script:

/Modeling/salton_line7base/vm/line7tomographymodels_
/salton7base_manip2.m

1.1 Last time...Inversions 11, 12, and 13

In October, inversions 12 and 13 were run; it turns out the "final" model I had before did not include constraints on the interface from the MCS reflector picks. Inversions 12, and the final (13) were to correct this.

Inversions 12 and 13 were run with MCS constraints; the final model had a poorer chi sq than the other model; the question was why. The best misfit came from inversion iteration 21, raytracing iteration 22, after applying the nullspace shuttles method. This chi sq was 1.88, whereas without the MCS data it's 1.3. The differences between the two are not that great, but with the MCS constraints the model looks a little splotchier because of where the layer 1 rays are turning. The original final model, from inversion 11, can be seen in figure Figure 1; the final model with MCS constraints is seen in Figure 2.

Alistair suggested looking at the reflection residuals:

"I would look at how well, or not, the prediction of the previous model simply fits the trend in MCS reflection times, i.e. does it predict an increase in reflections times at about the same rate as seen in the MCS data? If it does then it is possible that

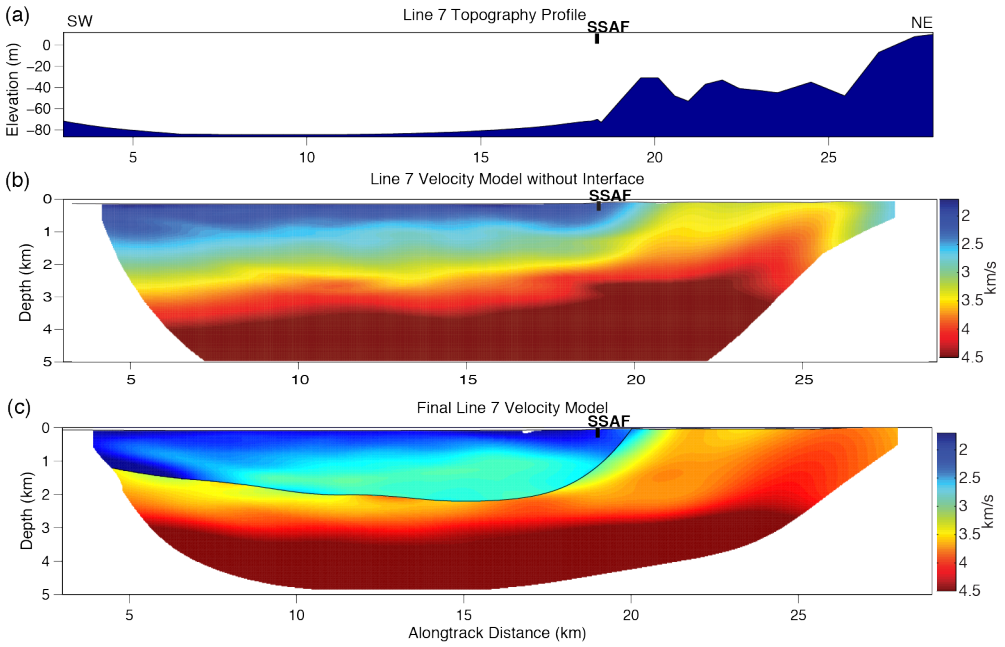

Figure 1: Inversion 11 final model, without MCS constraints. (a) shows a topography profile; (b) shows the model without an interface; (c) shows the final model, with no MCS constraints, and with an interface. Chi sq = 1.3.

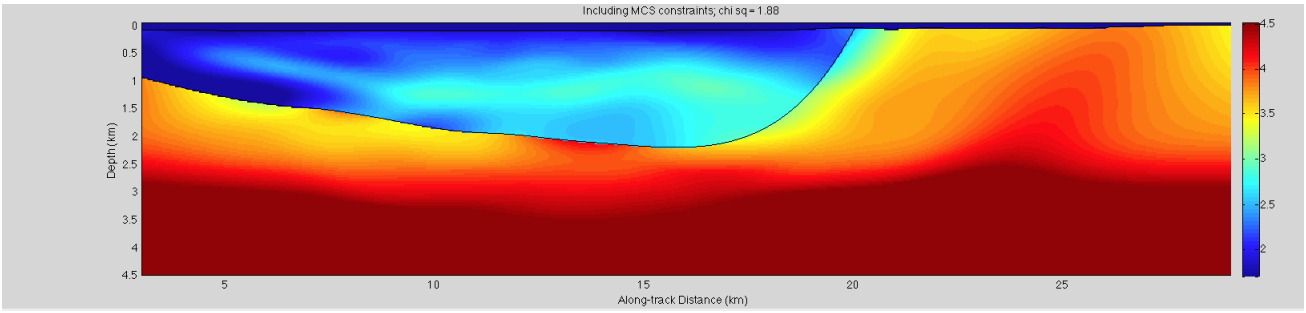

Figure 2: Inversion 13 final model, with MCS constraints. Chi sq = 1.88.

the is mostly a static time shift in your MCS picks relative to the OBS times. If the trends aren't really compatible then you probably are doing about as well as you can in reconciling the different data within an single model. and we should probably reconsider the possibility of the MCS reflections transgressing velocity contours."

To determine if this higher misfit is due to a consistently offset reflector, I plotted the just the reflection ray paths of the model with MCS constraints (Figure 3).

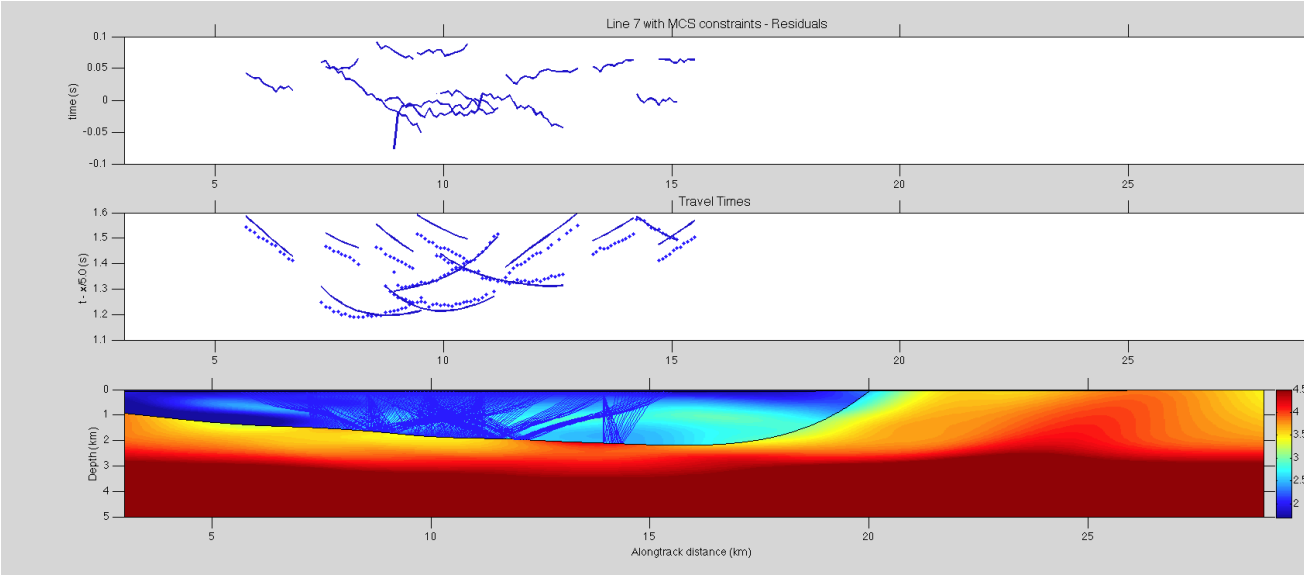

Figure 3: Inversion 13 final model ray path residuals.

1.2 Inversion 14

Start running inversions with varying interface surface traces. For inversion 14, run an example with the SSAF trace set at x=18.94299186; this is commented in salton7base_manip2.m.

The starting model is under inversion14, and is named salton7base_14_0.vm, seen in Figure 4. This inversion will include constraints from MCS data; therefore, the file salton7base_1_4.ray will be included; this is the ray file for the MCS reflector picks. The raytracing csh file is salton7base_raytr14.csh and includes append = 1, so that the rays from the MCS file will be appended to the rayfan.

The other settings are as follows:

set maxnode = 300, set cmax = 0.75, set gdx = 1041, set gdy = 1, set gdz = 323

set stx = 10, set sty = 0, set stz = 9, set ang = 0.5

set tstat = 0.0, set xextension = 2.0, set yextension = 2.0

Rayfan plotting is in script plot_salton7_raypaths_14.m.

The inversion csh file is salton7base_14.csh. The parameters are as follows:

set sr = 10.0, set sz = 5.0

set slh = 0.02, set jph = 0.005, set rfh = 0.1, set tstath = 0.04

set reg0 = 1.0, set reg1 = 1.0, set reg2 = 4.0

set asr = 5.0

set crf = 2, set cjp = 1

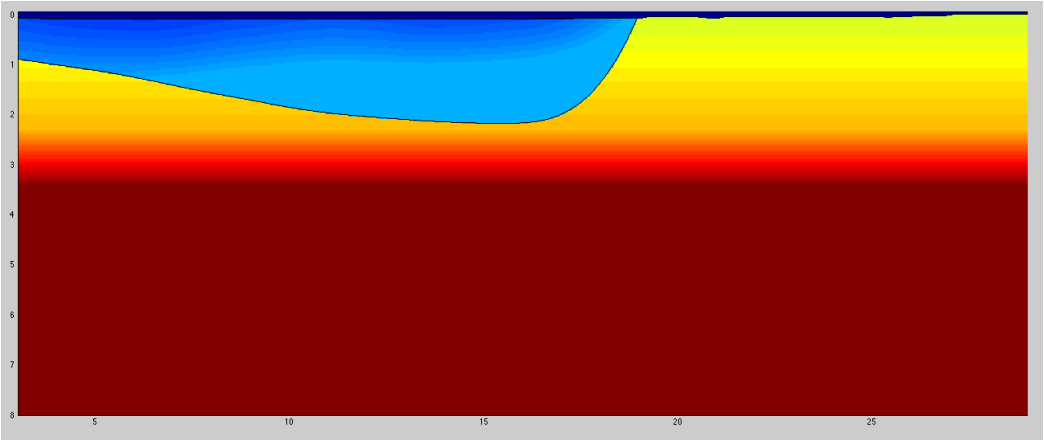

Figure 4: Inversion 14 starting model.

1.3 Raytracing and Inversion Output

Found in the tables 1.3, Table 1.3.

Raytr, It =	tmean	trms	chi sq	chi r	meanErr
It0	-0.0514	0.1174	73.2913	50.0788	0.0241
It1	-0.0182	0.1075	47.3309	43.8783	0.0241
It2	-0.0068	0.0906	25.6917	25.2468	0.0241
It3	-0.0131	0.0644	14.3934	13.6786	0.0241
It4	-0.0135	0.0527	8.7668	8.3057	0.0241
It5	-0.0110	0.0446	5.2944	5.2898	0.0241
It6	-0.0117	0.0382	3.1804	3.3014	0.0241
It7	-0.0116	0.0360	2.5369	2.7169	0.0241
It8	-0.0112	0.0349	2.2200	2.4544	0.0241
It9	-0.0116	0.0339	2.0821	2.3345	0.0241
It10	-0.0110	0.0338	1.9729	2.2349	0.0241
It11	-0.0104	0.0336	1.9733	2.2920	0.0241
It12orig	-0.0108	0.0336	1.9329	2.2353	0.0241
It12	-0.0039	0.0439	3.2228	3.4501	0.0241
It13	-0.0114	0.0346	1.9718	2.1610	0.0241
It14	-0.0112	0.0335	1.8335	2.1037	0.0241
It15	-0.0101	0.0337	1.8931	2.2218	0.0241
It16	-0.0120	0.0340	2.0673	2.2598	0.0241

Table 1: Inversion 14: Raytracing outputs.

Inv, It =	set chi sq =	out chi sq =	Penalty
It0	45	45.460	55886.17
It1	25	25.561	62766.52
It2	14	14.326	69724.12
It3	8	7.9459	75484.60
It4	5	4.9981	77469.94
It5	3	2.9994	86143.92
It6	2.3	2.3256	84903.17
It7	2.1	2.1429	81591.07
It8	1.8	1.8184	86594.72
It9	1.8	1.8618	83126.27
It10	1.8	1.8382	81169.54
It11	1.8	1.8382	79752.90
It12	2.0	2.0432	79529.48
It13	1.7	1.7128	83947.84
It14	1.7	1.7564	81046.24
It15	1.7	1.7376	79148.52

Table 2: Inversion 14: Inversion outputs.

Friday, 9 January 2015

1 Continuing Inversion 14

Continuing from Thursday.

1.1 Inversion 14 steps and results

Continued running Inversion 14 (output referenced in 1.3 and Table 1.3).

Run nullspace shuttles on inversion iteration 11 (vm 12). The pre-shuttled model, with a chi sq of 1.9329, is the best fit so far but is quite splotchy. See in Figure 5. I used salton7_shuttle_update.m to create the shuttled model;

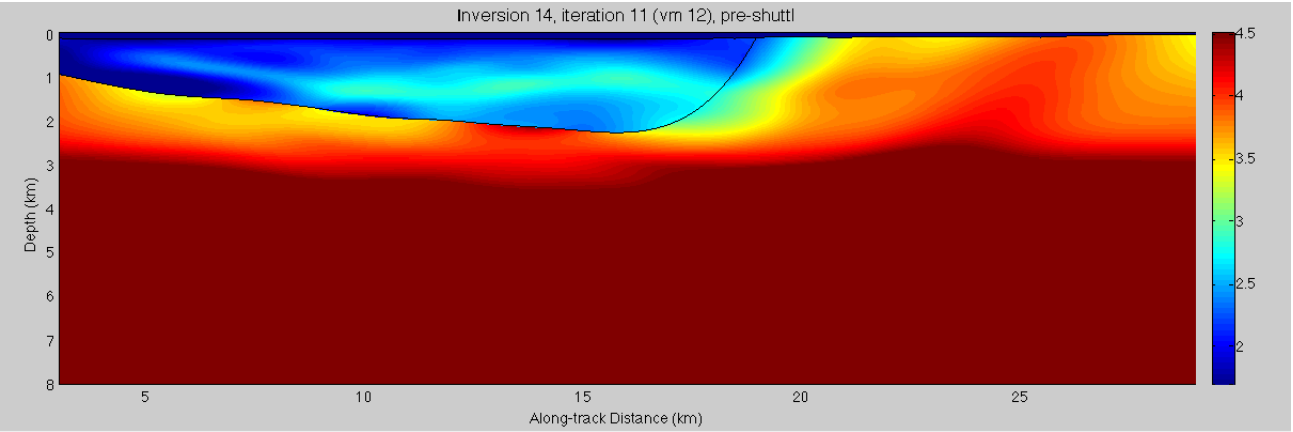

Figure 5: Inversion 14, iteration 11 (vm 12), pre shuttle.

Moving forwards, I named the output, shuttled model "Shuttles/line7shuttles/salton_smshuttle_inv14.vm". This was copied into inversion14/, and renamed to salton7base_14_12.vm. In inversion14, I renamed 12.ray, 12.vm, 12_rough.vm, and 12_raytr.out to orig.

In inversion_temp, I renamed all iteration 11's to _orig; including the anz, inz, nlr, rhsc, rhsn, sol, vecm_in, and vecm_out iteration 11's.

After this, ray trace on the new shuttled model; so re-run ray-tracing iteration 12. In the tables, the pre-shuttled statistics (ray-

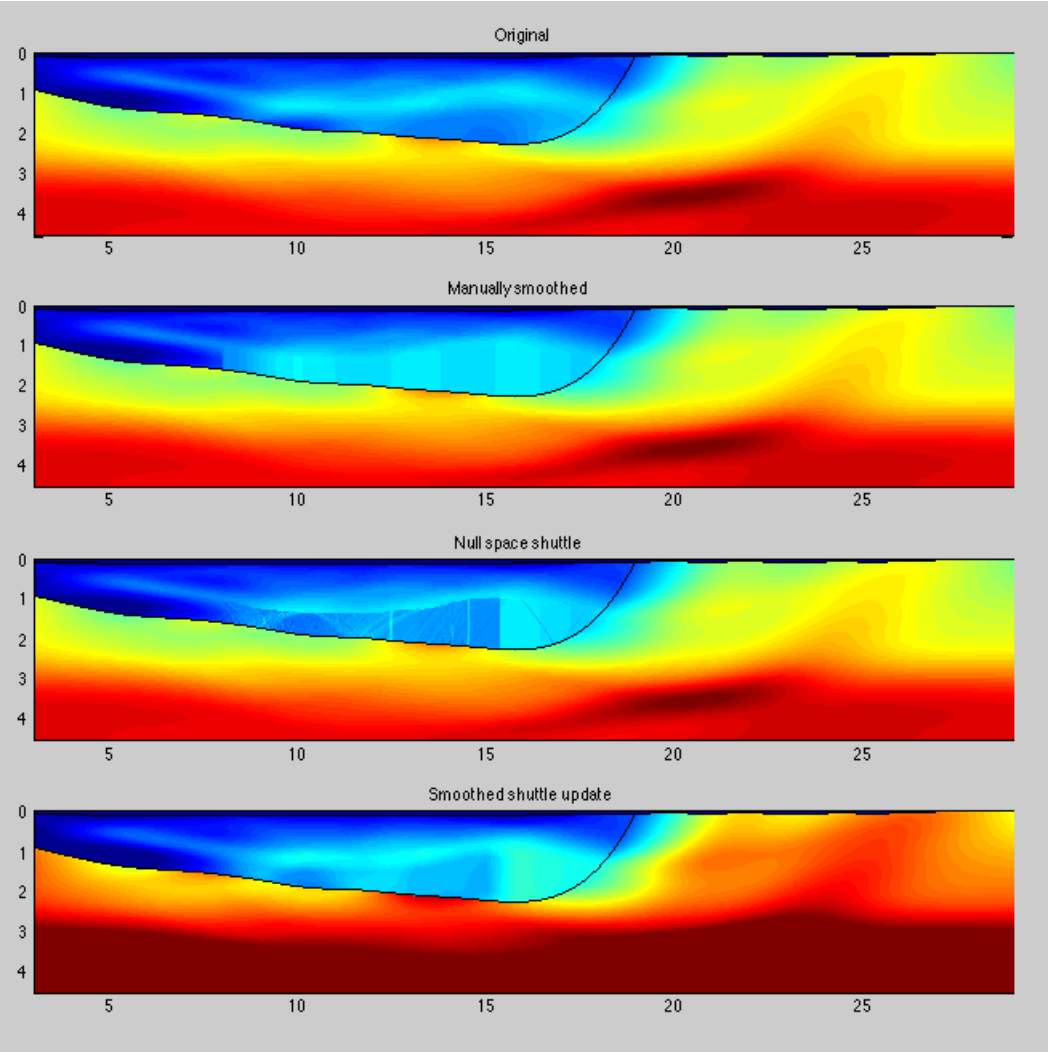

Figure 6: Inversion 14, iteration 11(vm12), post shuttle.

tracing it12) have been renamed to original. The post-shuttled raytracing will be the new It12; this velocity model is in Figure 6.

After several more iterations, I find that vm 14 (raytracing iteration 14, inversion iteration 13) has the lowest misfit (chi sq = 1.8335), and looks the "best" (the smoothest). The final model is seen in Figure 7.

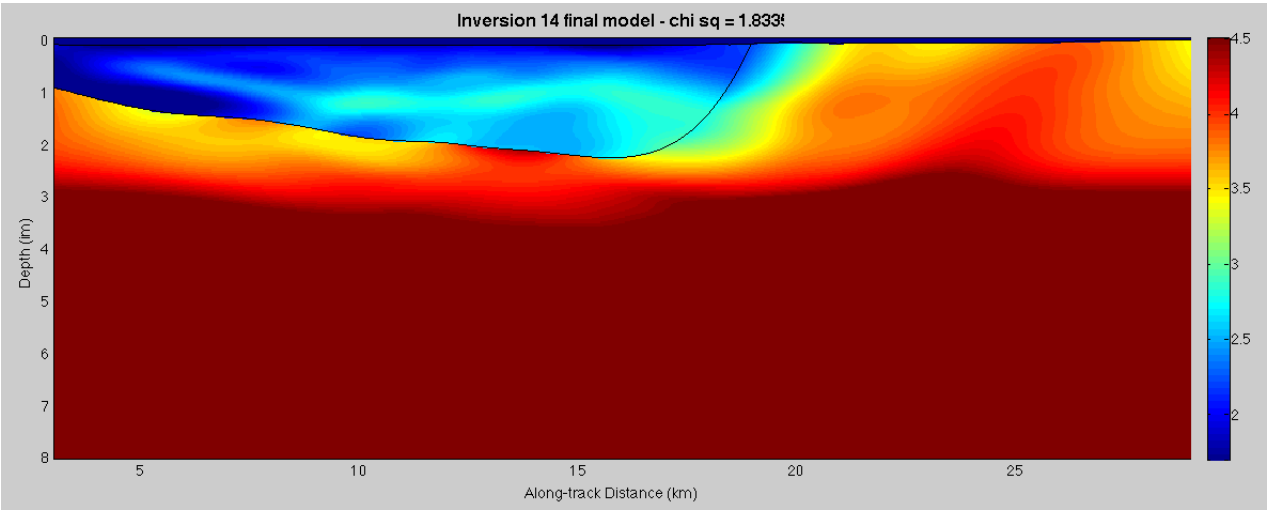

Figure 7: Inversion 14, final model. Vm number 14; chi sq = 1.8335.

Thursday, 15 January 2015

1 Inversion 15 - Interface to the W of the SSAF trace

Starting inversion 15. Here, the interface intersects the surface at 17.9km along-profile, about 1 km west of the surface trace of the SSAF.

To create the starting model, I once again used the script salton7base_manip2.m. The output model (starting model) is salton7base_15_0.vm, in inversion15/. This is seen in Figure 8. This inversion will include constraints from MCS data; therefore, the file salton7base_1_4.ray will be included; this is the ray file for the MCS reflector picks. The raytracing csh file is salton7base_raytr15.csh and includes append = 1, so that the rays from the MCS file will be appended to the rayfan.

The other settings are as follows:

set maxnode = 300, set cmax = 0.75, set gdx = 1041, set gdy = 1, set gdz = 323

set stx = 10, set sty = 0, set stz = 9, set ang = 0.5

set tstat = 0.0, set xextension = 2.0, set yextension = 2.0

Rayfan plotting is in script plot_salton7_raypaths_15.m.

The inversion csh file is salton7base_15.csh. The parameters are as follows:

set sr = 10.0, set sz = 5.0

set slh = 0.02, set jph = 0.005, set rfh = 0.1, set tstath = 0.04

set reg0 = 1.0, set reg1 = 1.0, set reg2 = 4.0

set asr = 5.0

set crf = 2, set cjp = 1

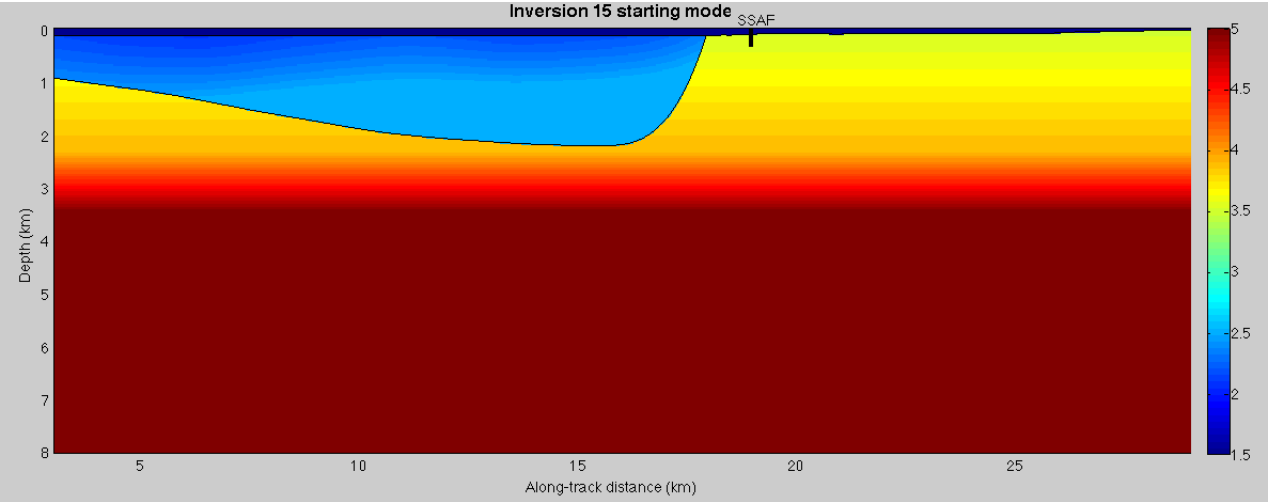

Figure 8: Inversion 15 starting model.

1.1 Raytracing and Inversion Output

Output found in 1.1 and Table 1.1.

Raytr, It =	tmean	trms	chi sq	chi r	meanErr
It0	-0.0529	0.1197	77.0745	52.4152	0.0241
It1	-0.0222	0.1102	52.0758	47.1082	0.0241
It2	-0.0055	0.0948	29.0273	28.6880	0.0241
It3	-0.0134	0.0696	17.7654	16.8745	0.0241
It4	-0.0135	0.0586	11.9874	11.4367	0.0241
It5	-0.0111	0.0494	7.6122	7.5095	0.0241
It6	-0.0098	0.0456	5.6006	5.6730	0.0241
It7	-0.0105	0.0420	4.3647	4.4582	0.0241

Table 1: Inversion 15: Raytracing outputs.

Inv, It =	set chi sq =	out chi sq =	Penalty
It0	50	50.182	144875.5
It1	30	29.006	149535.8
It2	17	17.770	152034.2
It3	11	11.190	153989.8
It4	7	7.1052	159624.0
It5	5	5.2451	154047.7
It6	4	4.0112	153415.7
It7	3		

Table 2: Inversion 15: Inversion outputs.

Bibliography

[1] Leslie Lamport, LaTeX: A Document Preparation System. Addison Wesley, Massachusetts, 2nd Edition, 1994.