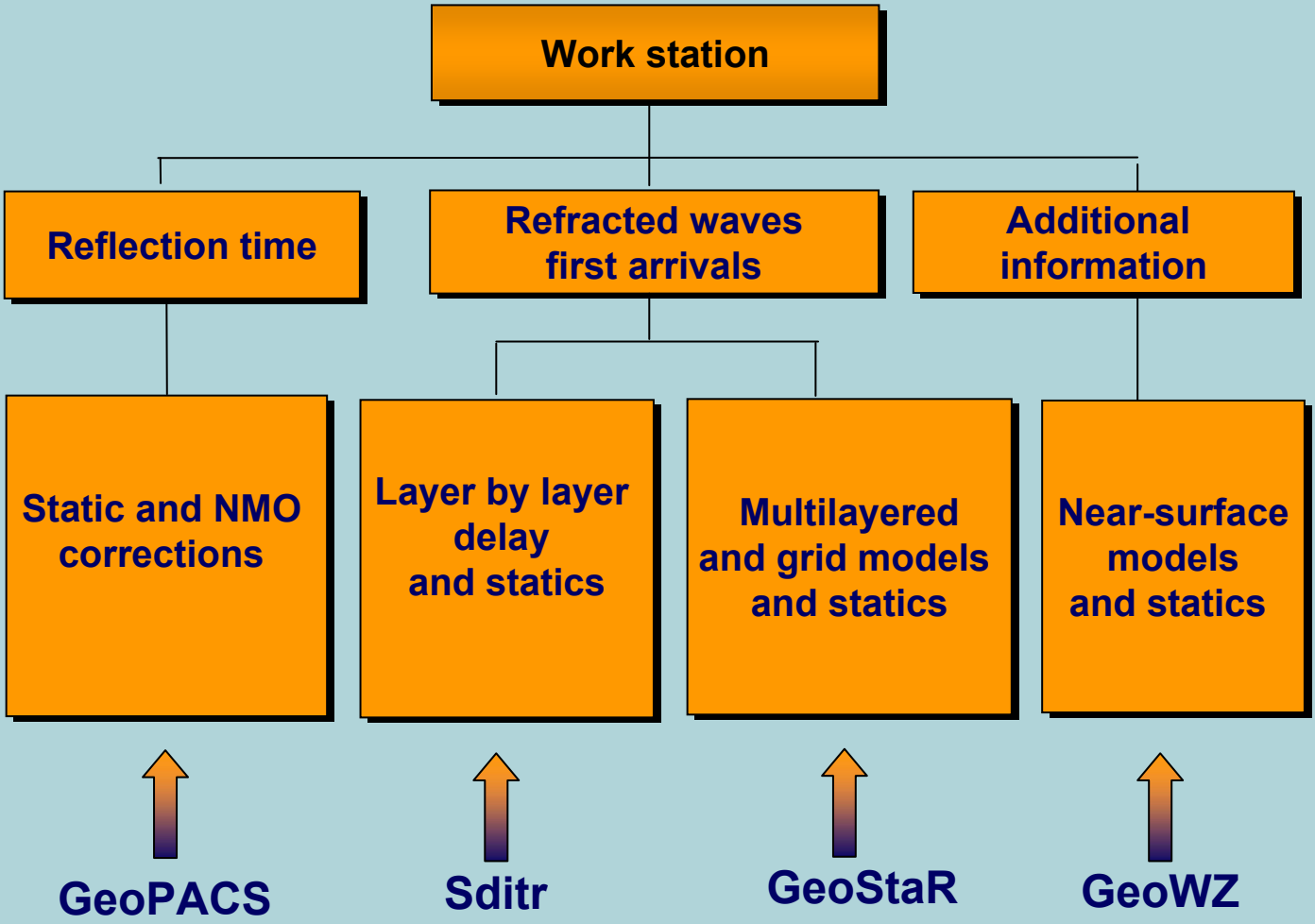
GeOlympus Workstation



GeoPACS determines static and NMO corrections on the basis of apriori distribution of the horizon velocities and time assigned either on model interval or on all stack traces. PP,SS and PS wave types are supported.

GeoPACS corrects automatically as static as NMO corrections.

GeoPACS allows to set the horizon position on stack traces, to define automatically the horizons position on neighboring gather or line data, calculate as short-period (with trend removal) as medium-period statics. Due to thin setting of the horizons it is possible to determine large amplitude statics (100 ms and more, up to 400ms for shear wave statics)

Sditr –well known and widely used solution for layer by layer delay, statics and refractor velocity estimation, source and receiver repositioning etc. Sditr offers fast processing of big data volumes in 2D and 3D cases.

GeoStaR is the interactive tool which allows to build and refine near-surface layers' model and calculate LVL static corrections using refracted wave first arrivals data.

GeoStaR can be used when there is multilayered or 3D variable on LVL velocity and depth i. e. when it is not possible to specify the offset range on which first arrivals are determined by head wave from dominant refractor

GeoWZ allows to load and to interpret upholes ,to trace first breaks on weathering shots, to interpolate surfaces after interpretation, to build layered models using built and loaded elevation and velocity surfaces, to calculate static corrections

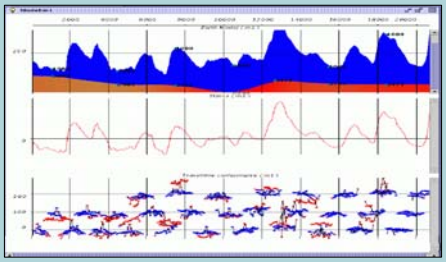
GeoStaR

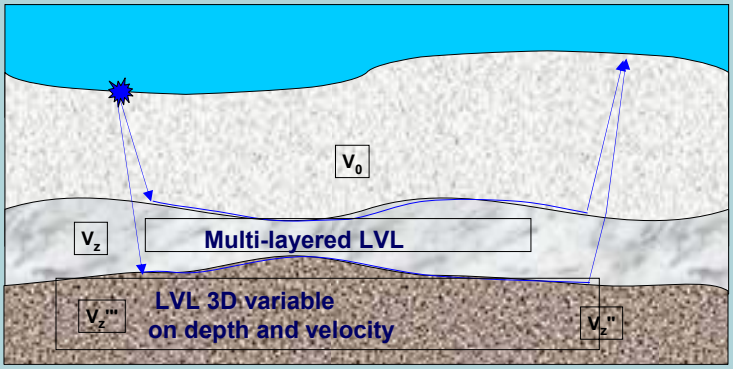
GeoStaR - interactive tool which allows to build and improve near-surface layers' model and calculate LVL static corrections using refracted wave first arrivals data.

Weathering zone model

Static corrections

Correspondence to travel time





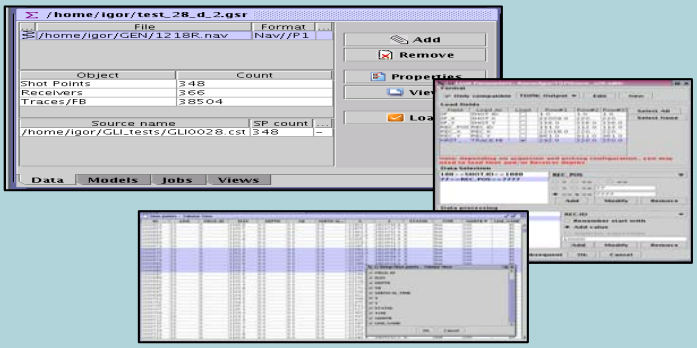
GeoStaR can be used when there is multilayered or 3D variable on LVL velocity and depth i. e. when it is not possible to specify the offset range on which first arrivals are determined by head wave from dominant refractor

GeoStaR – workflow

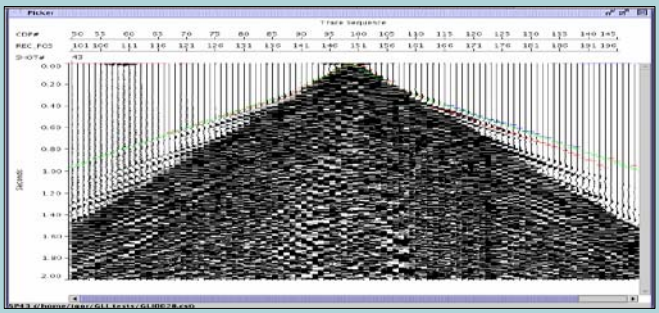
- Data loading
- Control and data QC
- Near-surface model building
- Near-surface model iterative improvement
- Near-surface model QC
- Static corrections calculation
- Statics QC
- Export of correction, models and information for solution QC

GeoStaR – data loading

Data are loaded from the files, tables or headlines of the traces, filled by the geometry of sources/receivers and first arrivals marks
Data loading is a three stages process which consists of data reading, its control and final loading.



GeoStaR – first arrivals tracing

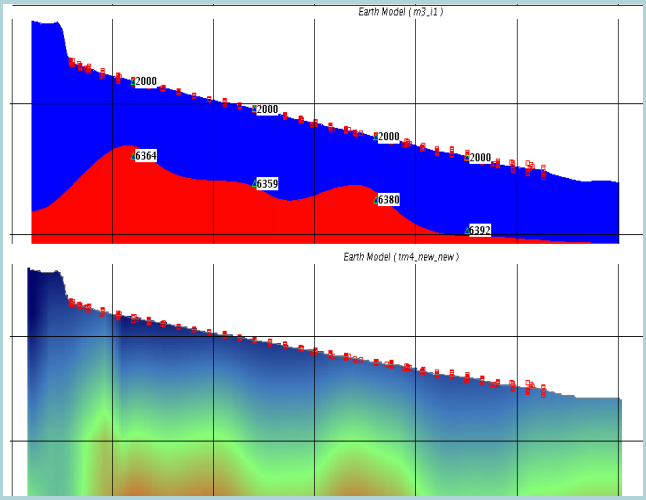


First arrivals tracing in manual, semi-automatic and automatic modes
Display of the seismograms with linear velocity law and calculated and loaded statics applied

GeoStaR

GeoStaR – near-surface modeling

Two ways of near-surface modeling are implemented



- *Layered model* – velocities and depths of the layers are represented by smooth functions, there is no vertical velocity gradient in each layer.

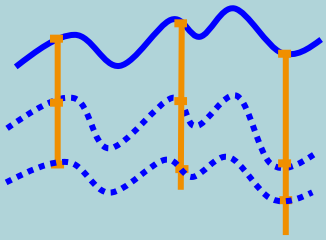
  This way is suitable for modeling of the environments with sharply cut borders and large velocity gradients.

- *Grid model* – is the survey area on lateral and vertical lines are divided on the cells in each nodes of these cells velocity value is set.

  Such models can be used for gradient environment models building, with velocity inversions.

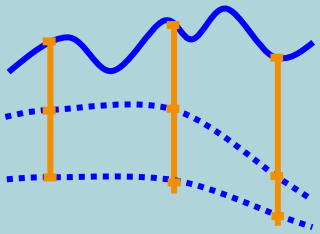
  Grid model is usually built by preliminary updated layered model.

Thickness smoothing



Smoothing, when the layer boundaries are similar to ground surface or sea bottom

Elevation smooting

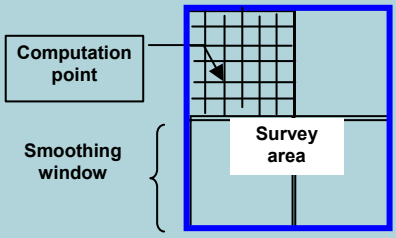


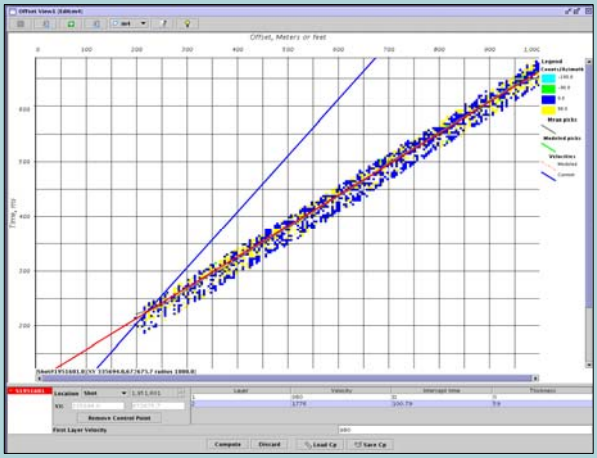
Smoothing, when the layer boundaries are not similar to ground surface or sea bottom

Smoothing parameters

To create environment model, horizons and layer velocities are presented as parametric smooth functions.

All the calculations are made on regular lattice, and than the coefficients for smoothing window are defined.





Layer depths and velocities are computed using interpolation of values at control points. The values of refracted wave velocity, depth and interception time are entered, loaded or digitized at a control point for each layer.

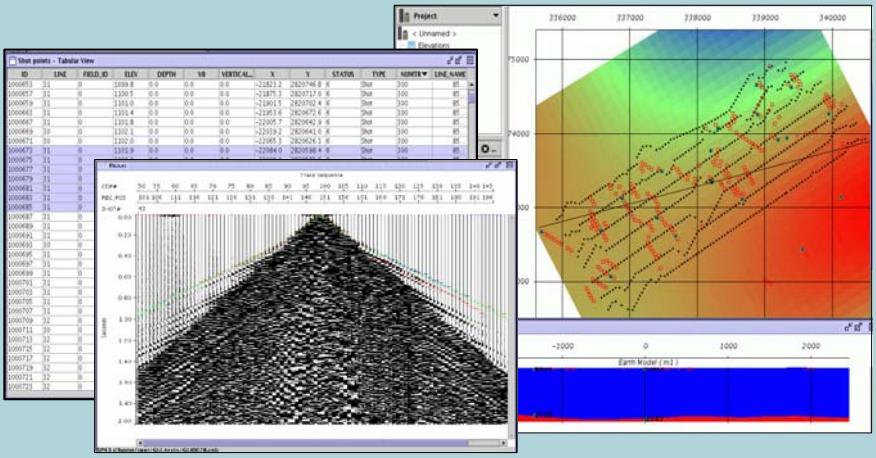
The values can be entered or digitized by drawing the best adequacy line(s) through the points of the "Time/Offset" graph.

Control points should be defined by different positions, covering the survey area.

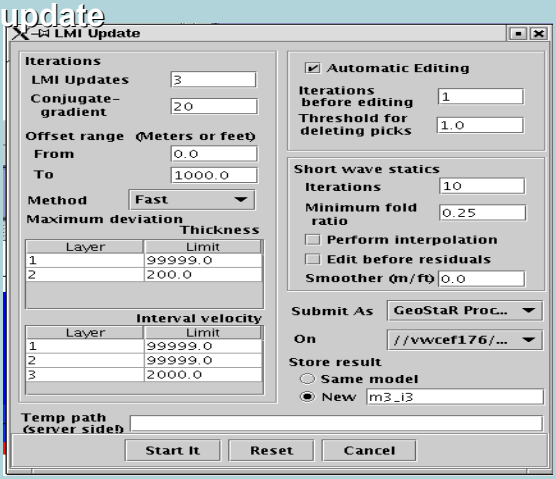
GeoStaR

GeoStaR – model QC

It is possible to use different information displays: maps, sections, graphs, tables, gathers for data and models QC at any stage of work



GeoStaR – near surface layered model update



- The model update is performed by a separate module, which can work on a remote computer
- To figure out optimal layered model modifications the iterative updating is applied to velocity and depth of each layer in order to minimize modelling errors
- On first iteration only layer depths are updated
- After the assigned number of iterations specifying layer depth/velocity the rest of modelling errors are allocated between sources and receivers (residual statics)

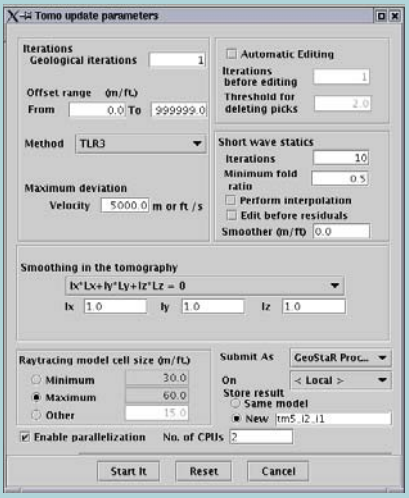
- To avoid the influence of first arrivals wrong marks it is possible to use auto editing: after the assigned number of iterations and residual static correction calculation, the marks with anomaly high values of residual statics are removed
- It is possible to limit the model modification area for additional normalization

GeoStaR – near surface gridded (Tomo) model update

Net model specification – is quite resource-intensive process, so the possibilities of multiple processor nodes and/or clusters can be used for this purpose

Several iterations are used when specifying a module, they include the following:

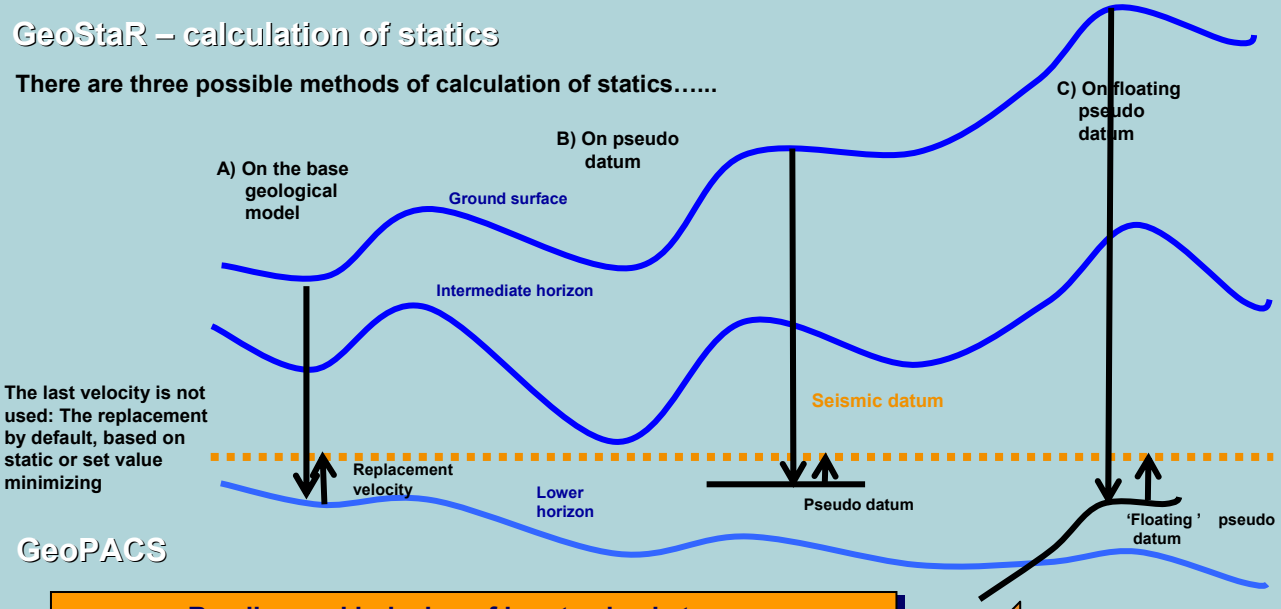
1. Time field estimation and source-receiver ray tracing
2. Computation of model travel times
3. Building equations set to define optimal model modification with permanent rays
4. Smoothing and regularization of equations set
5. Equations set solutions, calculation of optimal model modification



GeoPACS

GeoStaR – calculation of statics

There are three possible methods of calculation of statics…...



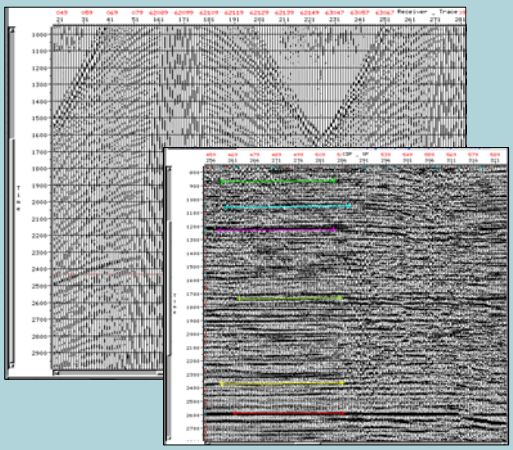
The last velocity is not used: The replacement by default, based on static or set value minimizing

GeoPACS

Workflow

- **Reading and indexing of input seismic traces**
- **Model trace building**
- **Calculation of trace cross correlation functions with model correlation with its continuous adaptation**
- **Building of multifactor model of travel time curve (travel time) for each CDP**
- **Location of optimum static and NMO corrections taking into consideration horizons weight, quality of tracing by solving algebraic equations set**
- **Smoothing of static and NMO corrections, optional trend removal (preserving middle- and long-period components)**
- **Recording of the corrections and information for solution's QC**

GeoPACS – input data



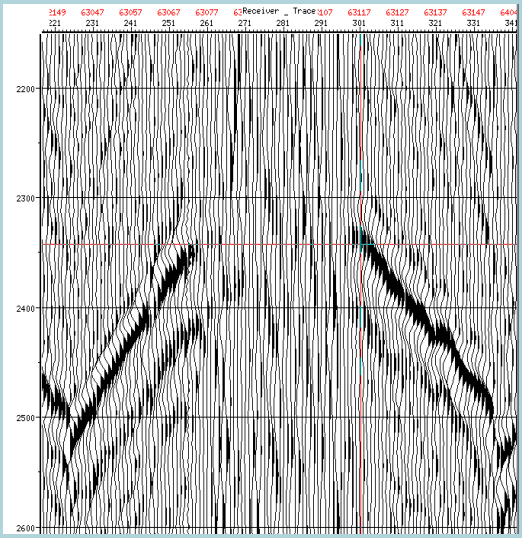
Input data are:

- Seismic traces without NMO corrections
- Apriori NMO corrections
- Seismic horizons
- (optional) apriori statics
- (optional) data of datum floating level
- Seismic traces can have random sorting and can be distributed among several files, each file can be more than 2Gb in size.

▪Seismic horizons can be set as on model as on the whole area. In the first case PACS defines automatically the horizon mark on each CDP .

GeoPACS

GeoPACS - calculation of cross-correlation function



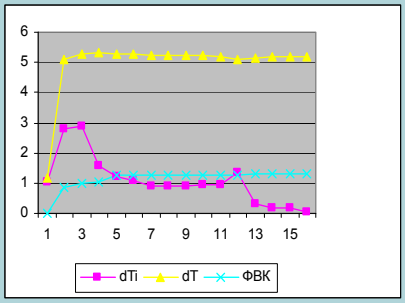
▪Calculation of cross-correlation function is made within the limits of set time window. Window base is determined by horizon mark on stack section (as set directly as defined after the tracing)

Method of cross-correlation of input traces with model is used for travel time curve tracing.

In normal mode it does not matter what phase is chosen for definition of horizon marks, however there are phase tracing modes at which the horizon mark is shifted to the nearest extremum of the specified polarity.

GeoPACS – problem solution

№	dTi	ΦBK	dT
1	1.052	0	1.187
2	2.777	8713	5.077
3	2.869	9938	5.269
4	1.578	10588	5.341
5	1.228	12511	5.288
6	1.075	12654	5.277
7	0.911	12715	5.225
8	0.921	12752	5.235
9	0.906		
10	0.936		
11	0.933		
12	1.331		
13	0.332		
14	0.191		
15	0.181		
16	0.044		

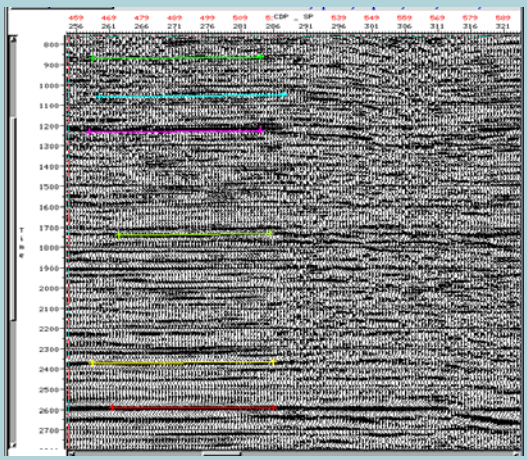


After calculation of inter-correlation function, the solution is made by iterative method of weighted least squares of over specified equations set, where unknowns are static and NMO corrections, and reflected travel time curve deviation is minimized from theoretical travel time curve.

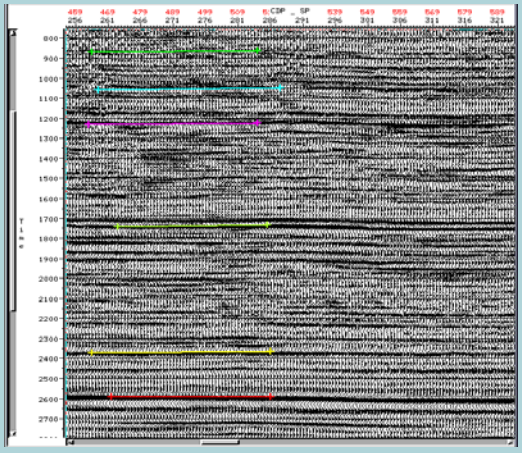
The additional information is used to regulate equation set – data about horizon “smoothness”, interval of solution search, interval of velocity scanning etc.

Two solution methods are possible with short- and medium-period static corrections.

GeoPACS – an example

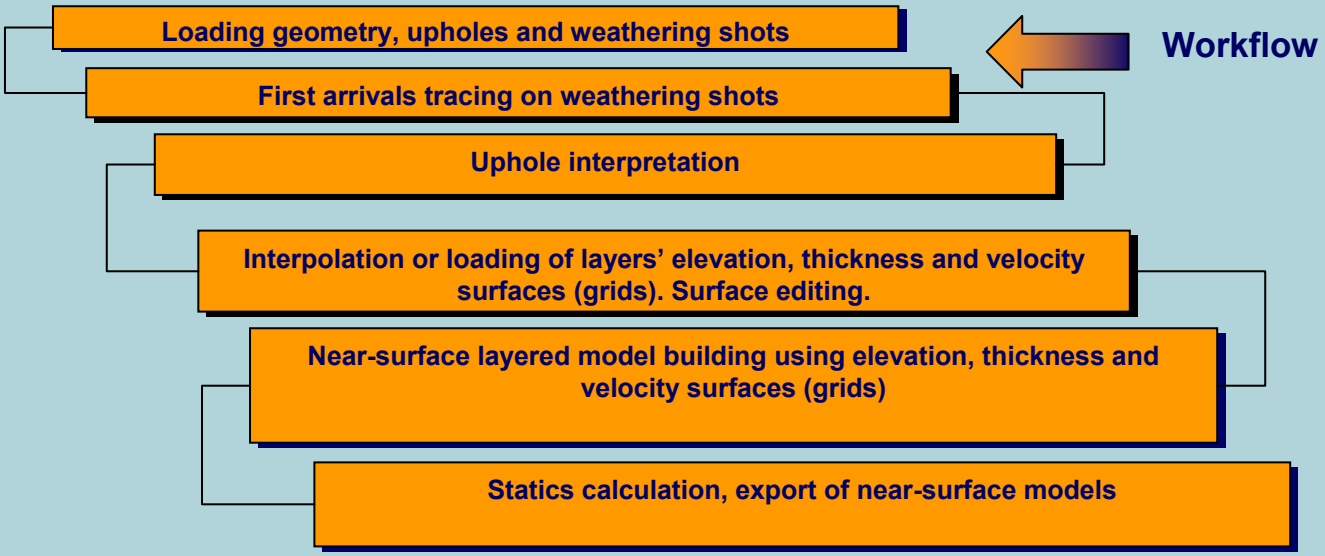


9 horizons which spread on the whole survey area are chosen on model interval. Short- and medium statics are calculated and applied.



GeoWZ

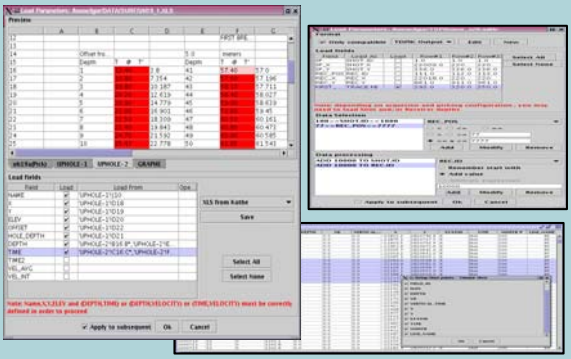
GeoWZ is the interactive tool, GeoWZ allows to load and to interpret upholes ,to trace first breaks on weathering shots, to interpolate surfaces after interpretation, to build layered models using built and loaded elevation and velocity surfaces, to calculate static corrections and to export models for further update in GeoStaR and other tools.



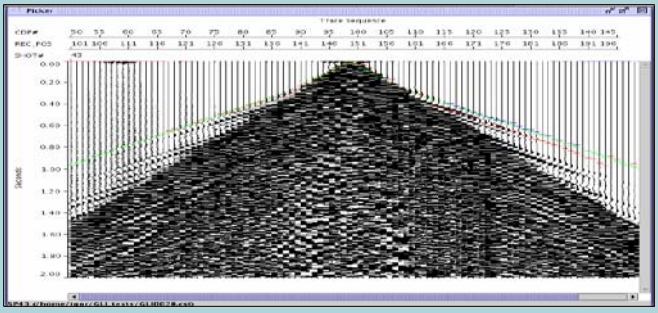
GeoWZ – data loading

Data are loaded from the files, tables or traces headers, filled by geometry of sources/receivers, first breaks; Excel tables, LAS- and text files with upholes.

Data loading is a three stages process which consists of data reading, its control and final loading.



GeoWZ – first arrivals tracing

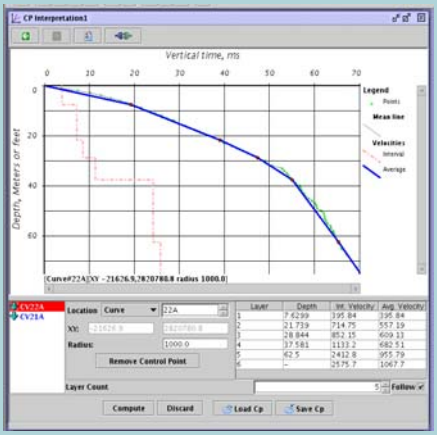


First arrivals tracing in manual, semi-automatic and automatic modes

Display of the seismograms with linear velocity law applied

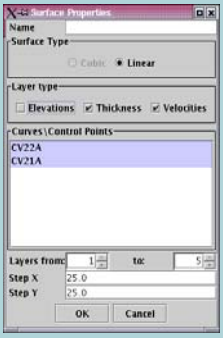
GeoWZ

GeoWZ – Upholes interpretation



Interpretation is performed using «Depth\Vertcal Time» display of the “CP Interpretation” diagram.
All upholes which fall inside defined search radius are displayed here along with layer border markers and interval velocities. The interpretation can be performed either graphically, by moving horizon markers along uphole curve (tabulated values are updated automatically) either by editing of layers’ depths and velocities in the table(the display is).
The results of the interpretation can be saved into control points file to re-used for model building in GeoStaR.

GeoWZ – surface interpolating and editing

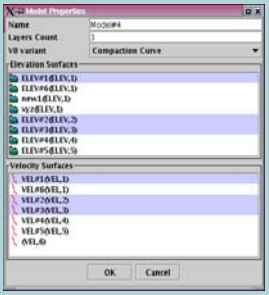


The interpreted layers’ depths and velocities are used to interpolate surfaces. используются для интерполяции поверхностей. Each surface represent one mono-valued function (thickness, elevation or velocity of defined layer). The set of interpreted curves and interpolation parameters can be adjusted for each surface independently of each other. But the many curves can be built and updated at the same time.

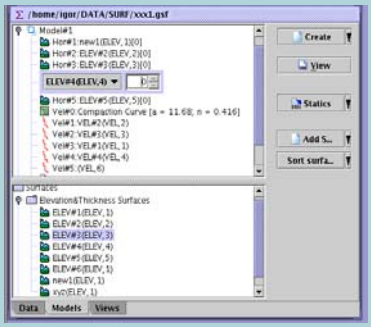
In the case of any uphole re-interpretation, all surfaces (and models built using such surfaces) are updated automatically.

There are some surface operations implemented : smoothing, filling with defined value, re-interpolation inside or outside of a defined polygon, or of whole surface. It is possible to perform mathematical operations on or apply simple mathematical functions to surfaces.

GeoWZ – building of near-surface models

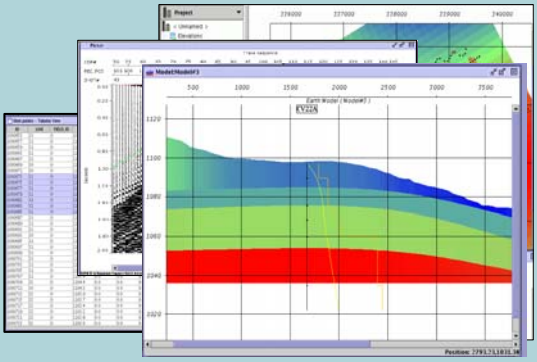


Each model is the set of pairs of velocity and either elevation or thickness surfaces for each layer. Some “weight” can be defined for layer in order to resolve intersection conflicts.



GeoWZ – QC of the model

It is possible to use different information displays: maps, sections, graphs, tables, gathers for data and models QC at any stage of work



GeoWZ – calculation of statics

There are three possible methods of calculation of statics:
on the base geological model, on pseudo-datum or on the floating pseudo-datum (see GeoStaR).