RTH method for forecasting productive zones of oil and gas condensate fields of the Nepsko-Botuobinskaya anticlyeza of Eastern Siberia

Outline

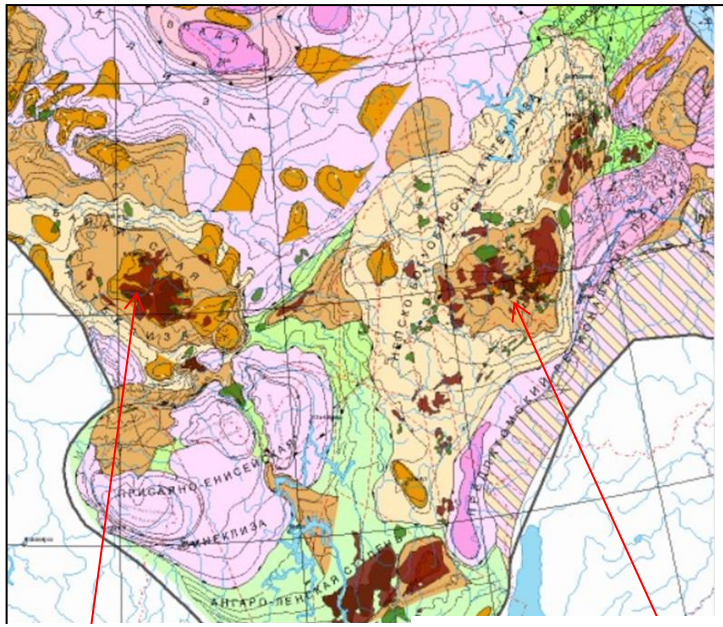
- ❑ Goals and objectives of the presentation
- ❑ Geological and stratigraphic description of the area
- ❑ RTH-Velocity Stratum Concept
- ❑ RTH-interpretation roadmap
- ❑ Illustration of RTH-interpretation roadmap step by step
- ❑ Conclusions

Goals and objectives of the presentation

- Description of the RTH-interpretation roadmap based on the new capabilities of the RTH approach
- Illustration of the basic concept of RTH-interpretation - "RTH-Velocity Stratum "
- Demonstration by examples of the effectiveness of the RTH method for predicting productive zones of oil and gas condensate fields in the Nepsko-Botuobinskaya anticlyeza in Eastern Siberia
- Discussion of the prospects for RTH-interpretation for solving the problems of geological exploration and production of hydrocarbons

Location the Nepsko-Botuobinskaya anticlyeza of Eastern Siberia

Structural and tectonic scheme of the Siberian craton

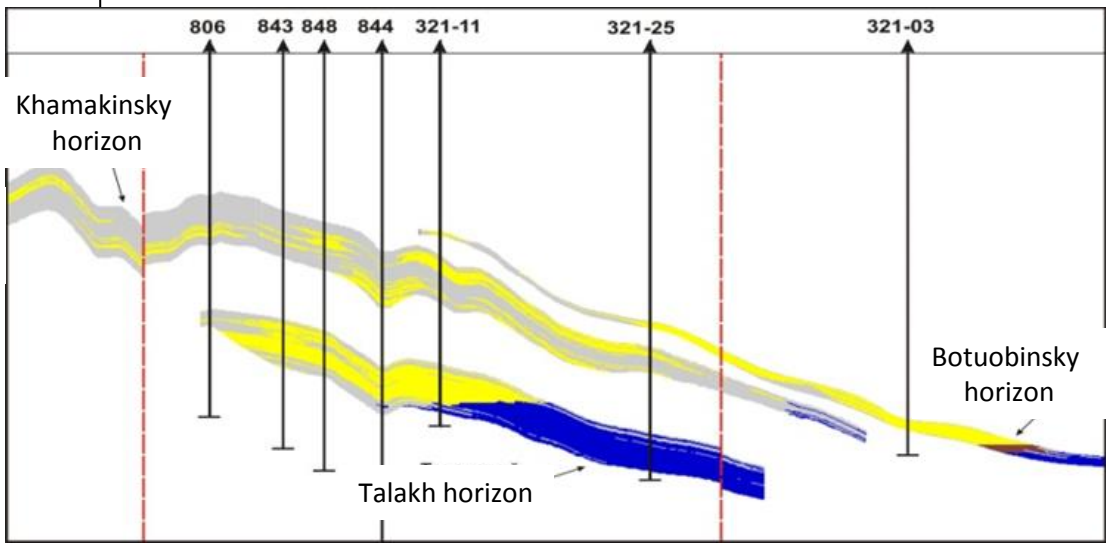


Baykit anticlyeza

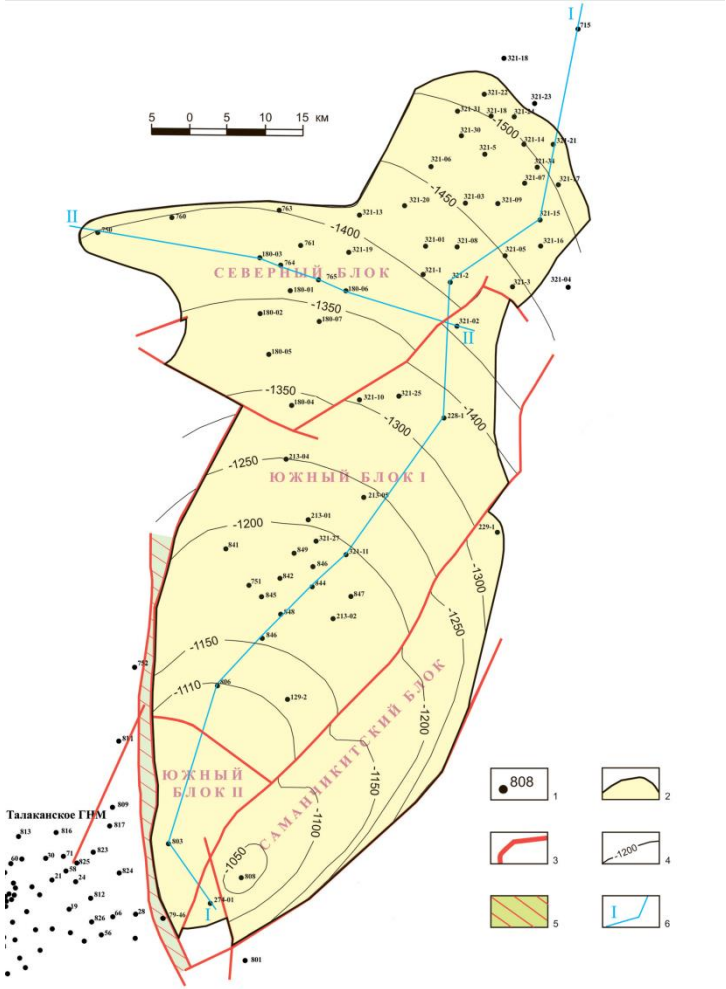
Nepsko-Botuobinskaya anticlyeza

Upper Vendian

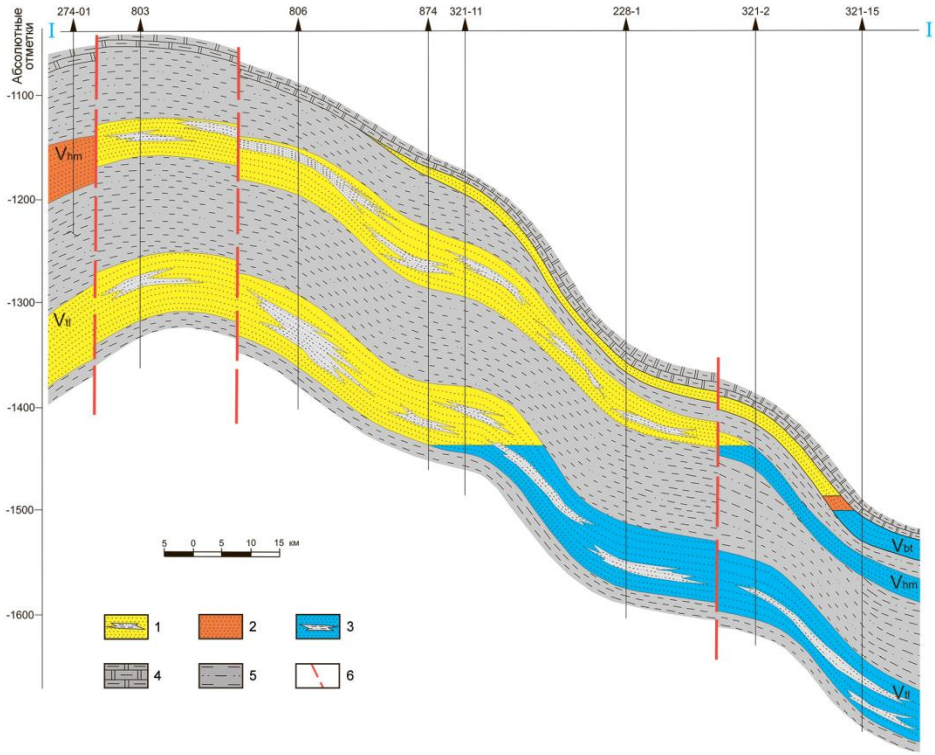
Geological section



Geological characteristics of Nepsko-Botuobinskaya anticlyeza



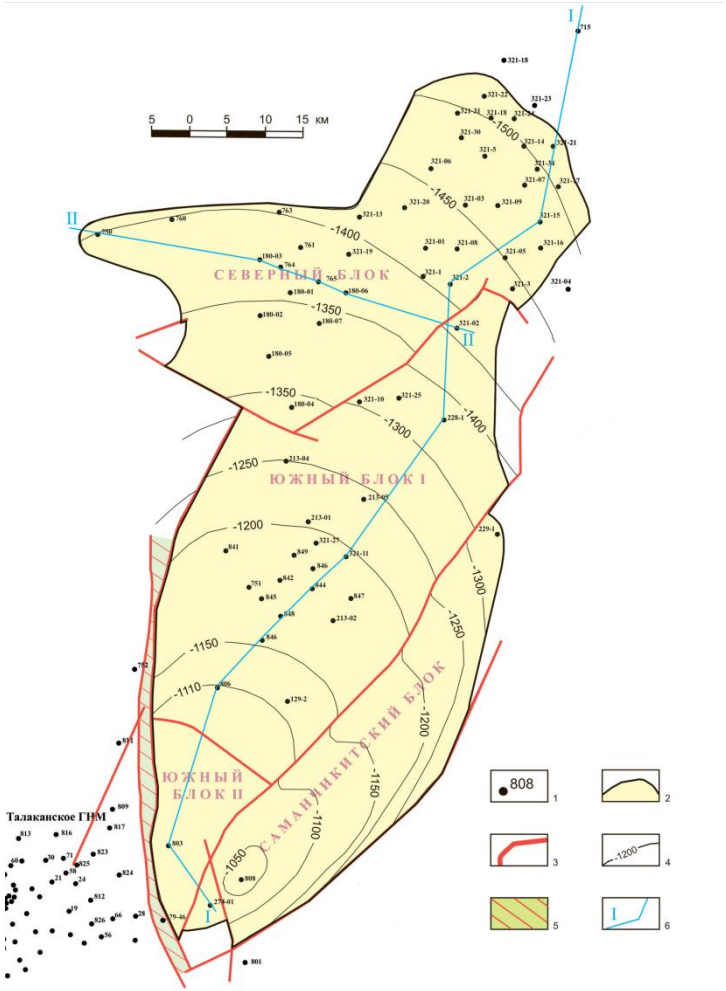
Structural map for the top of the Parshinskaya suite of the field:
1 - well number; 2 - field contour; 3 - tectonic faults; 4 - isohypses of the Parshinskaya roof suite; 5 - graben, 6 - lines of the studied profiles



Schematic profile section of the productive horizons of the field
along line I – I: 1 - gas-saturated sandstones with interlayers and lenses of clayey siltstones; 2 - oil-saturated sandstones
with interlayers and lenses of clayey siltstones; 3 - water-saturated sandstones with interlayers and lenses
clayey siltstones; 4 - mudstones; 5 - clayey dolomites; 6 - tectonic faults

LITHOLOGICAL-FACIAL AND GEODYNAMIC CONDITIONS OF FORMATION VENDIAN SEDIMENTS OF THE CHAYANDA DEPOSIT
V.E. Kryuchkov, A.G. Medvedev, I.B. Izvekov (Gazprom VNIIGAZ LLC)

Geological characteristics of Nepsko-Botuobinskaya anticlyeza



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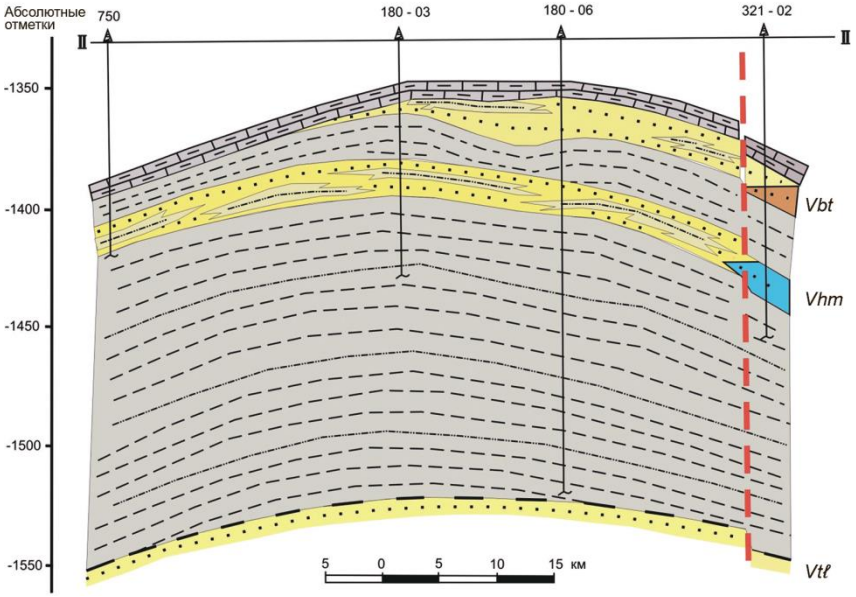

Schematic profile section of the productive horizons of the field along line II – II

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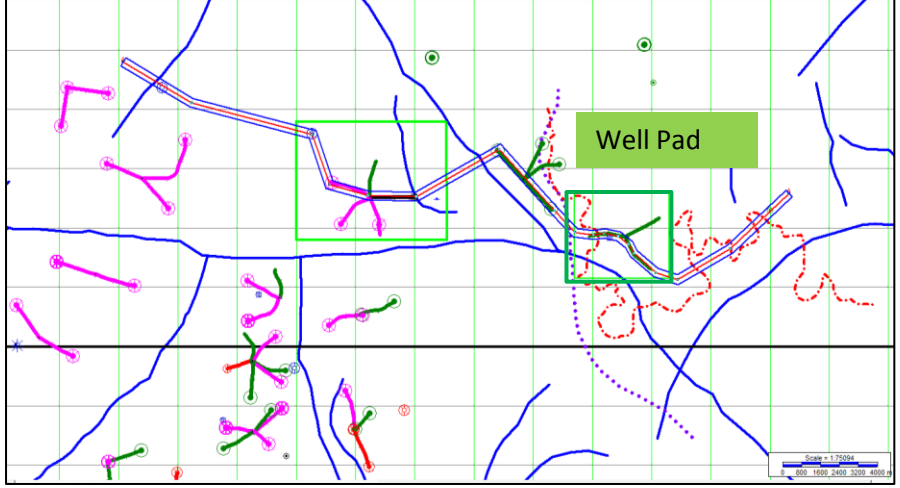
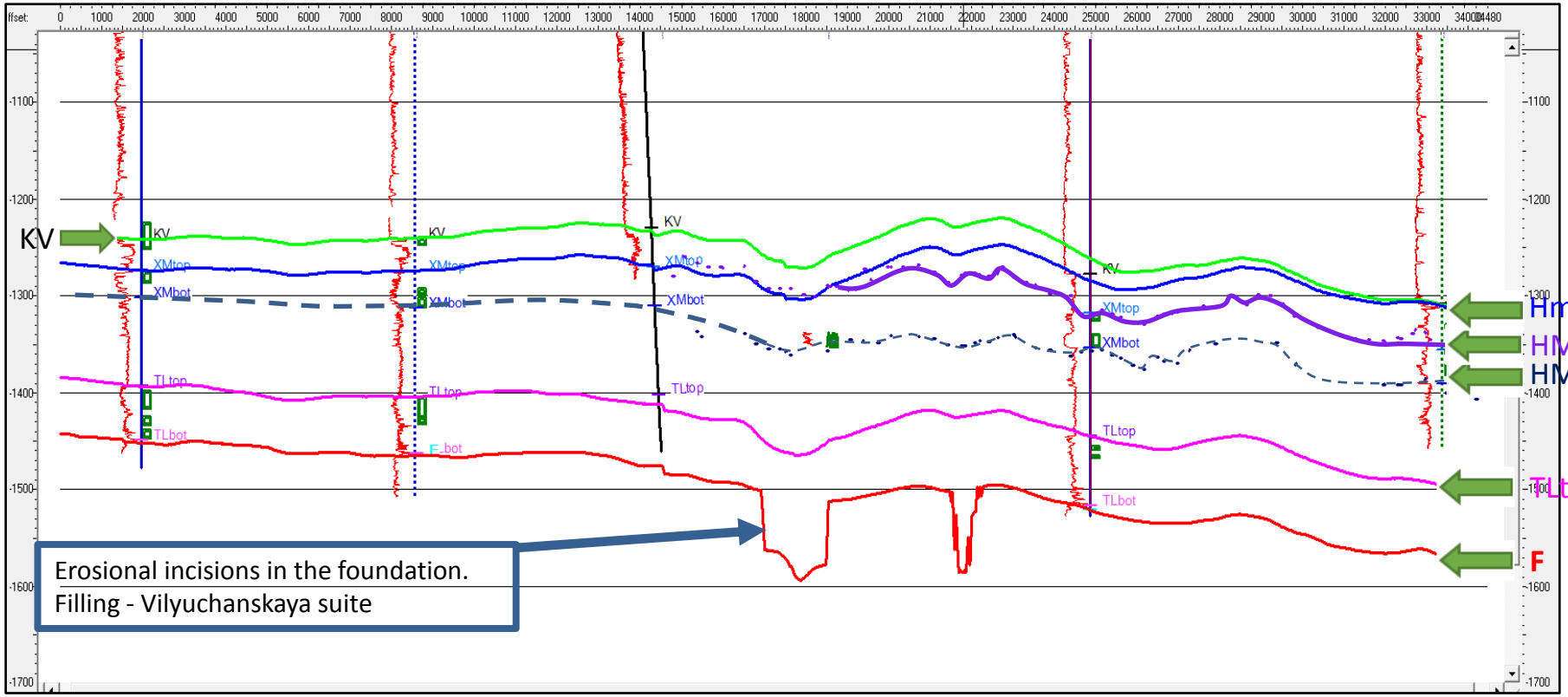
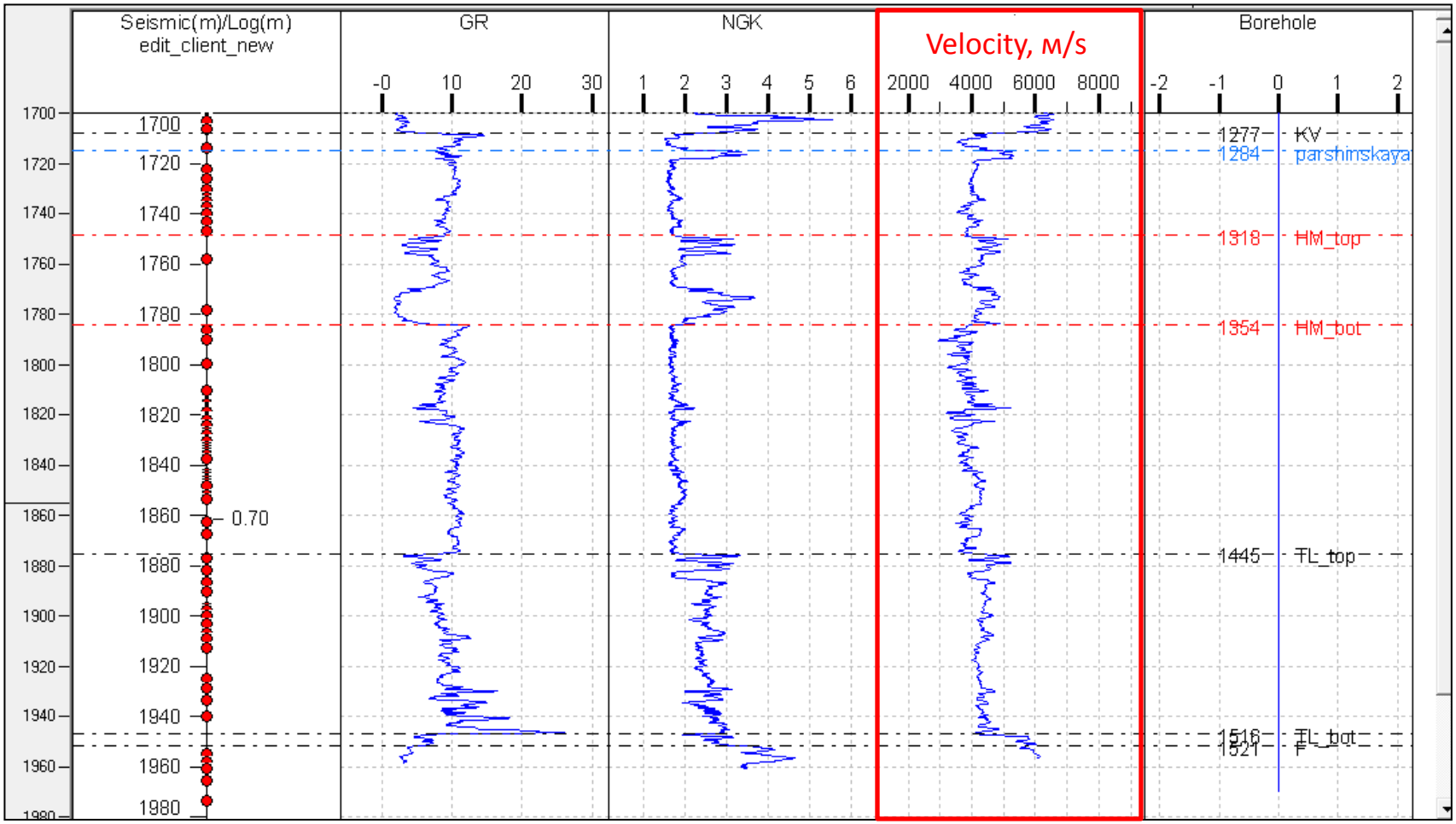
Depth section along the well line





Hmtop* - a variant of the structural constructions of the top of the Khamakinsky horizon before drilling well pad

Well log data in a vertical well of a well cluster. Target interval

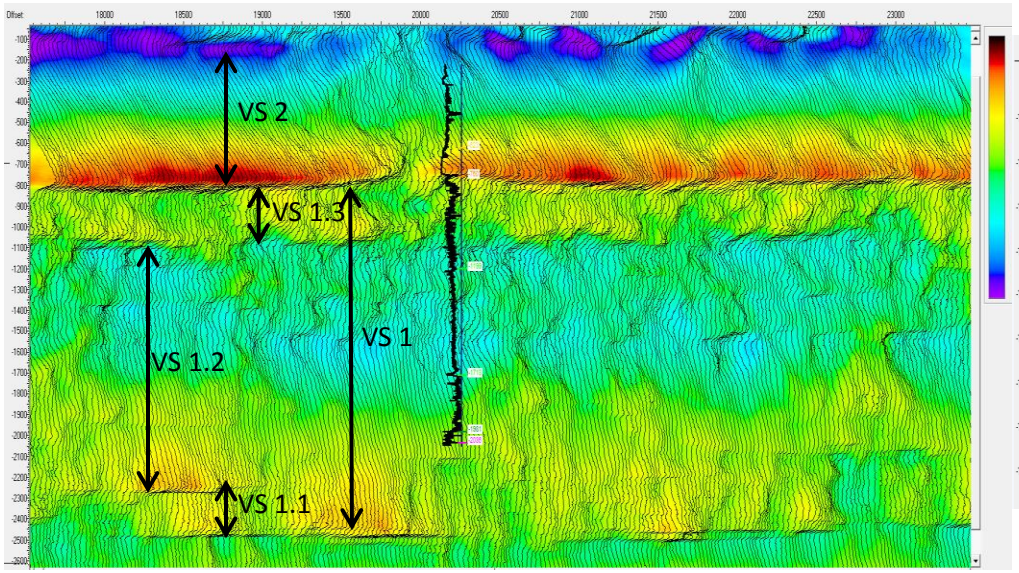


RTH-Velocity Stratum Concept

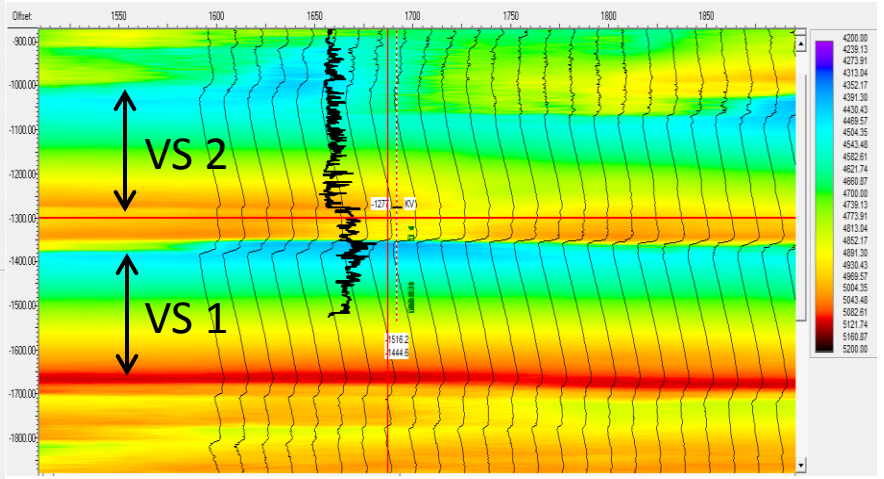
The concept of the RTH-Velocity Stratum (VS) is based on:

- the data of RTH-velocity with high spatial resolution
- the similar velocity patterns of the RTH-velocity variation within one RTH-velocity stratum both in depth and lateral
- the separation of RTH-velocity stratums from each other in depth by boundaries with sharp velocity inversion
- the hierarchies and nesting of RTH-velocity stratums of different thicknesses

Examples of the RTH-velocity stratums:



RTH-velocity. Depth resolution - 2.5 meters



RTH-velocity. Depth resolution - 5 meters

RTH interpretation stages

Stage 1 Extracting large layers of velocity (RTH-velocity stratum) from the RTH-velocity cube

Stage 2 Georeferencing of the RTH-velocity cube according to well logging data. Correlation over the area of the boundaries of RTH-velocity stratums. Binding of RTH-velocity stratums to reference reflecting horizons (RH). Construction of structural maps of the boundaries of RTH-velocity stratums and maps of their thickness

Stage 3 Identification of thinner RTH-velocity stratums, correlation of their boundaries using additional RTH attributes

Stage 4 Creation and analysis of maps of velocity and other attributes in the target productive intervals of the geological section

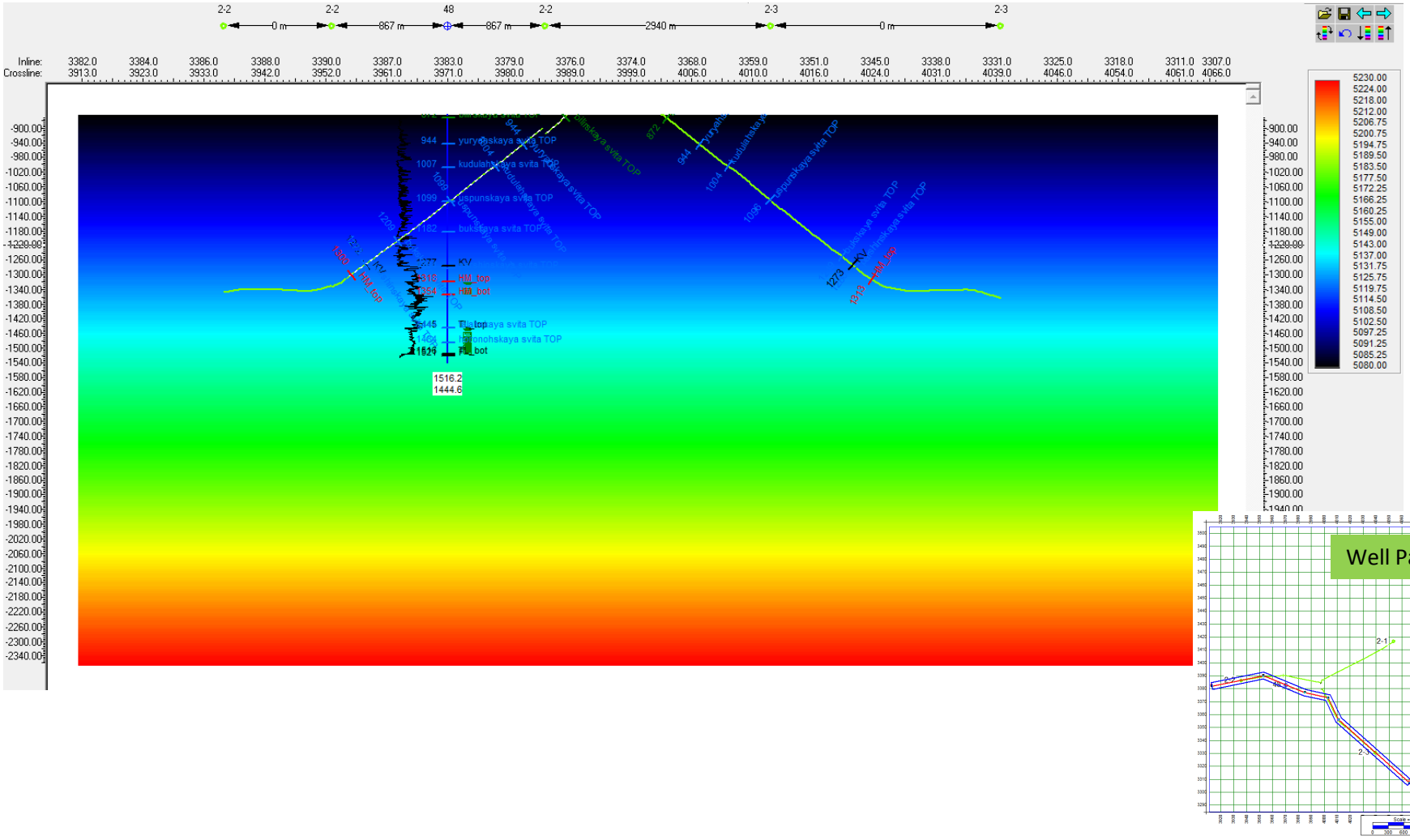
Stage 5 Revealing the dependences of petrophysical parameters on RTH-velocity. Creation of forecast maps of improved reservoir properties of productive horizons

Stage 6 Geosteering support for horizontal well drilling

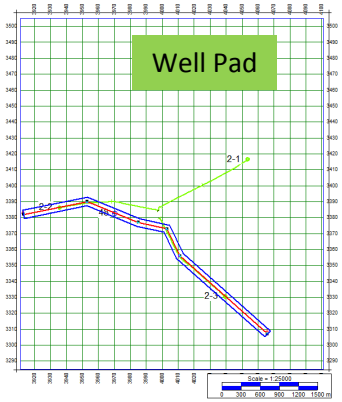
RTH interpretation stages

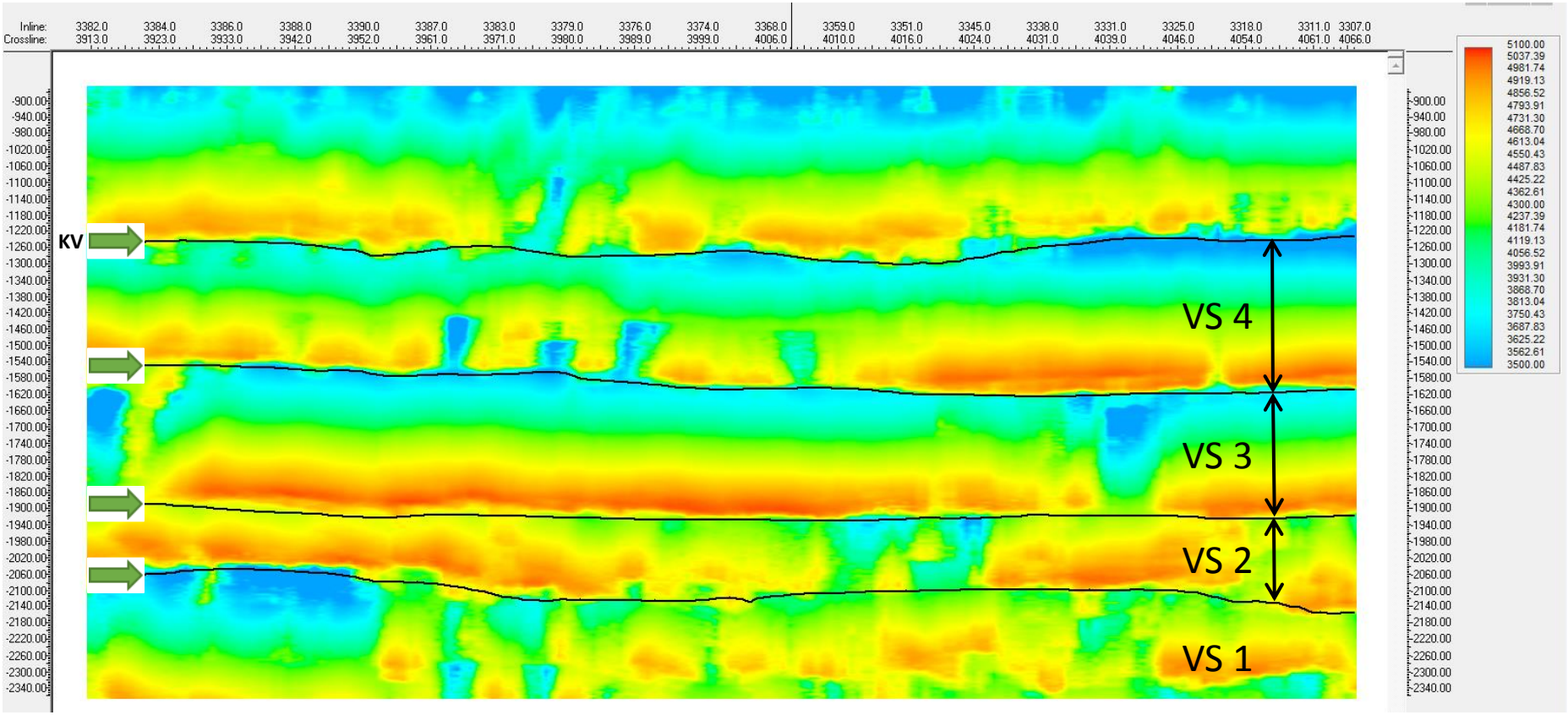
Stage 1 **Extracting large layers of velocity (RTH-velocity stratum) from the RTH-velocity cube**

Initial background RTH-velocity



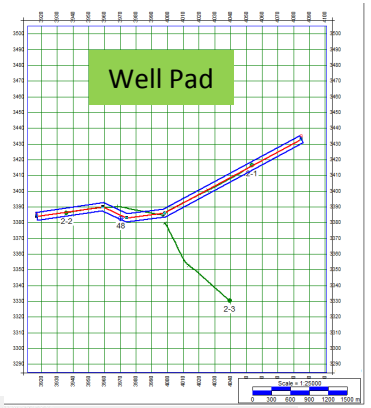
Depth section of the RTH velocity cube along the profile

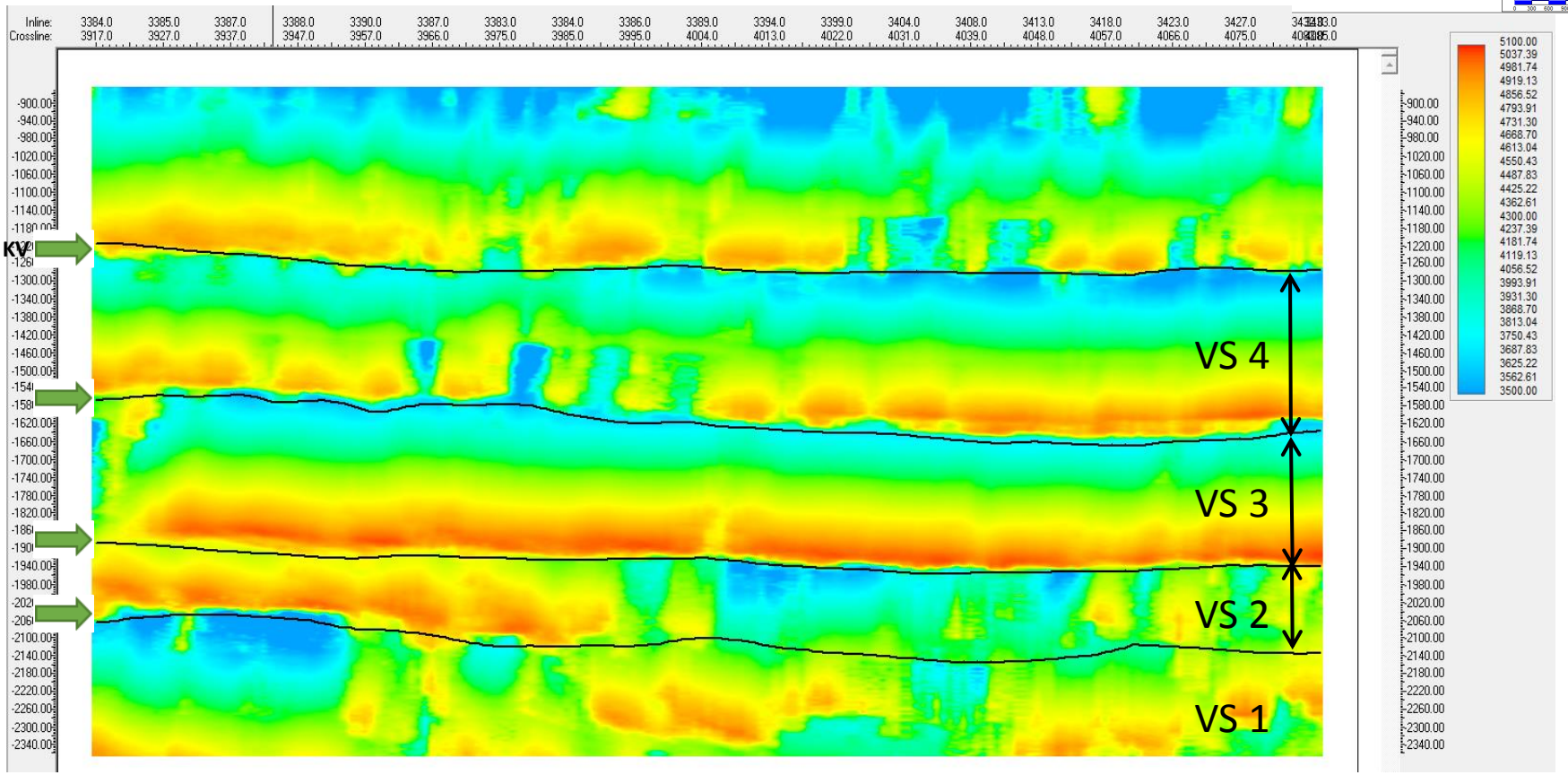




RTH-velocity scale, m/s

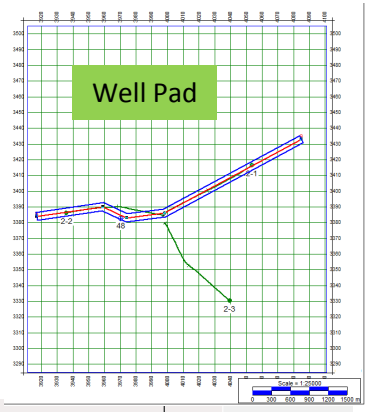
Depth section of the RTH velocity cube along the profile

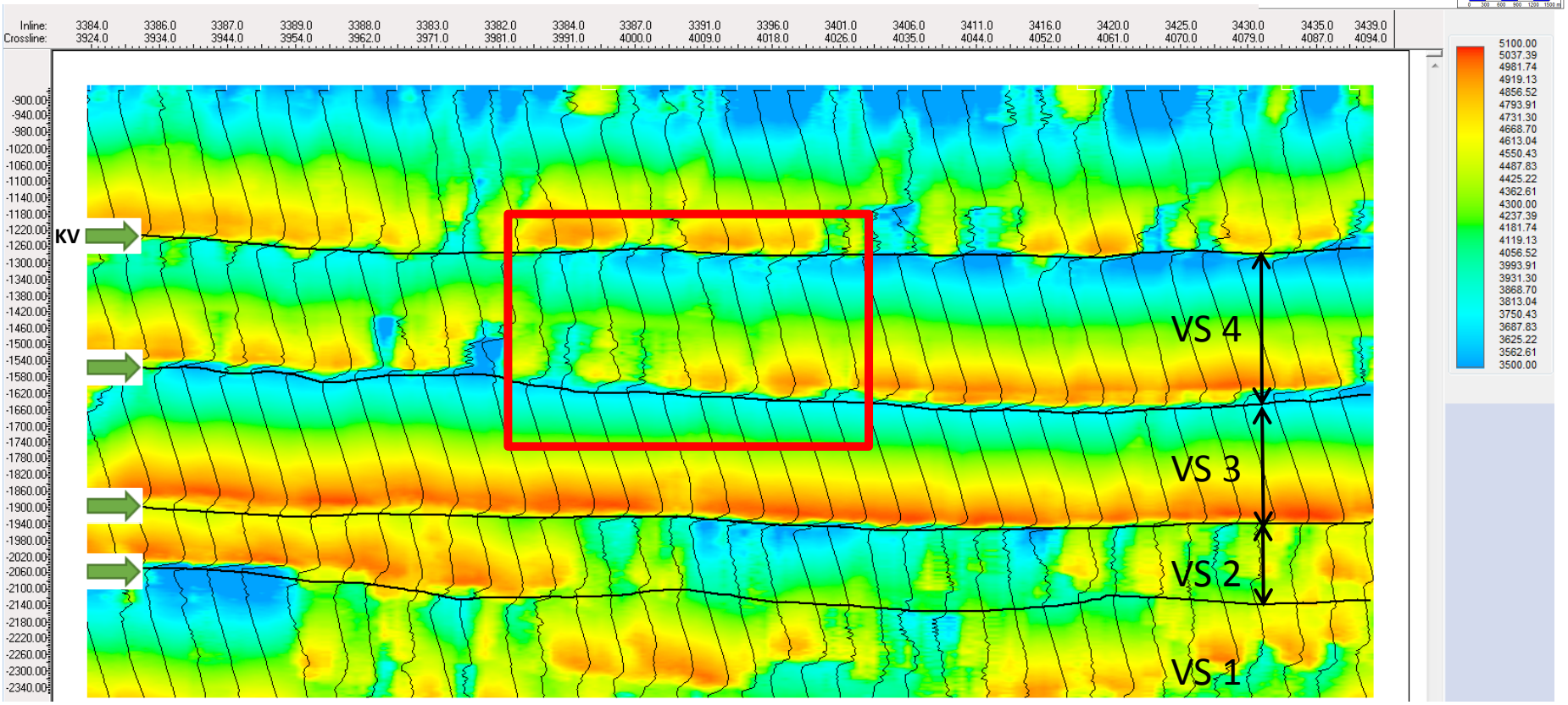




RTH-velocity scale, m / s

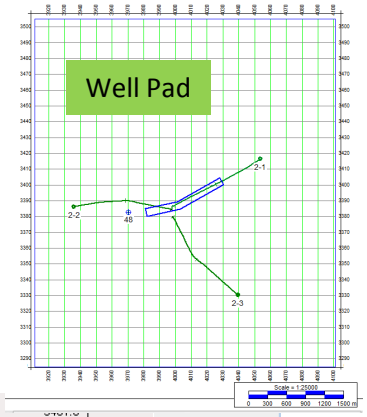
Depth section of the RTH velocity cube along the profile

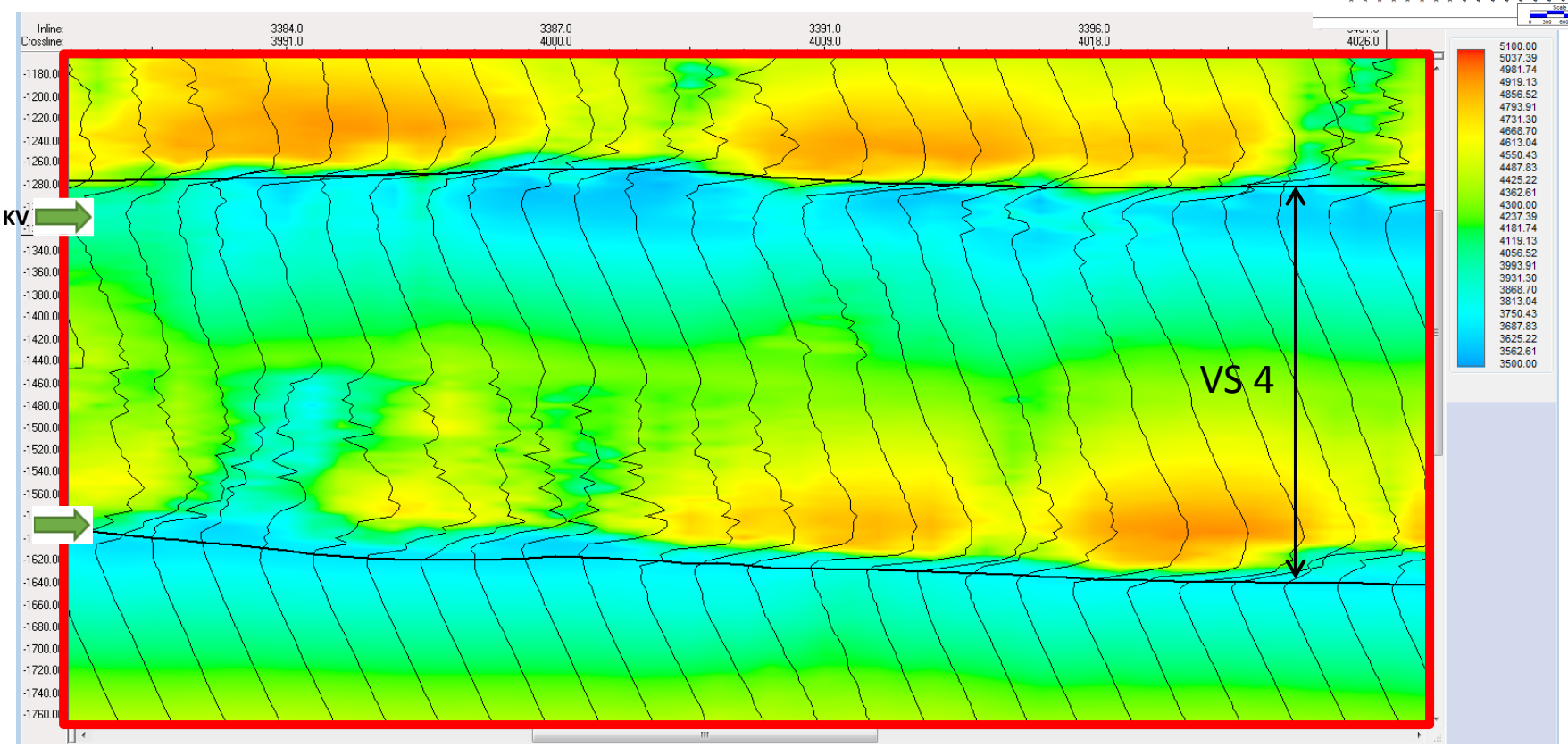




RTH-velocity scale, m / s. Wiggle - RTH-velocity

Depth section of the RTH velocity cube along the profile. Zoom



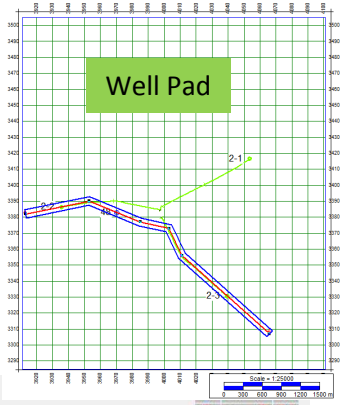


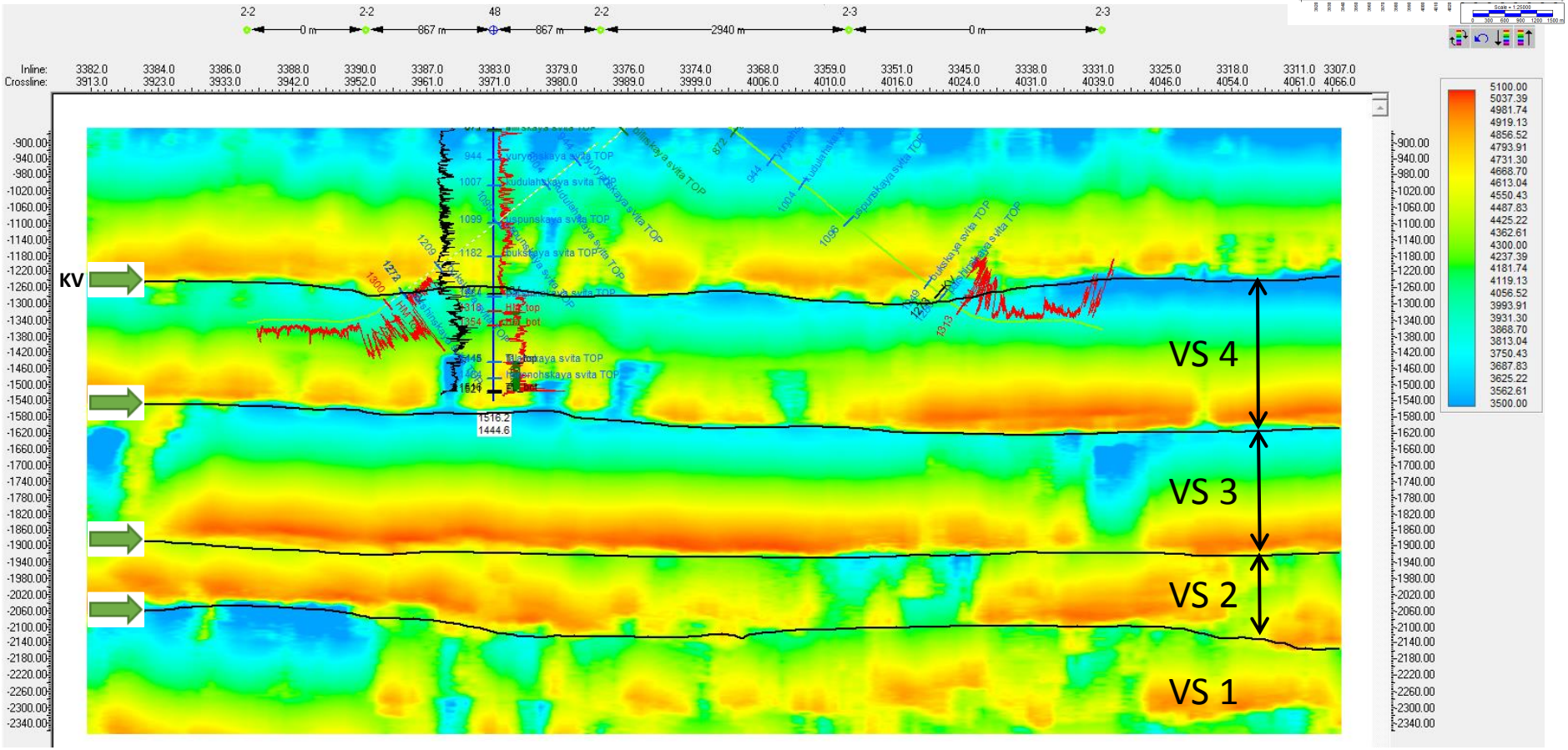
RTH-velocity scale, m / s. Wiggle - RTH-velocity

RTH interpretation stages

Stage 2 **Georeferencing of the RTH-velocity cube according to well logging data. Correlation over the area of the boundaries of RTH-velocity stratums. Binding of RTH-velocity stratums to reference reflecting horizons (RH). Construction of structural maps of the boundaries of RTH-velocity stratums and maps of their thickness**

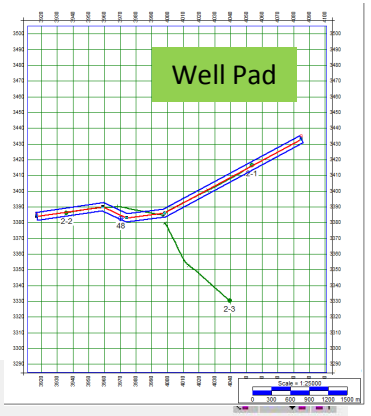
Georeferencing of the RTH-velocity cube according to well logging data

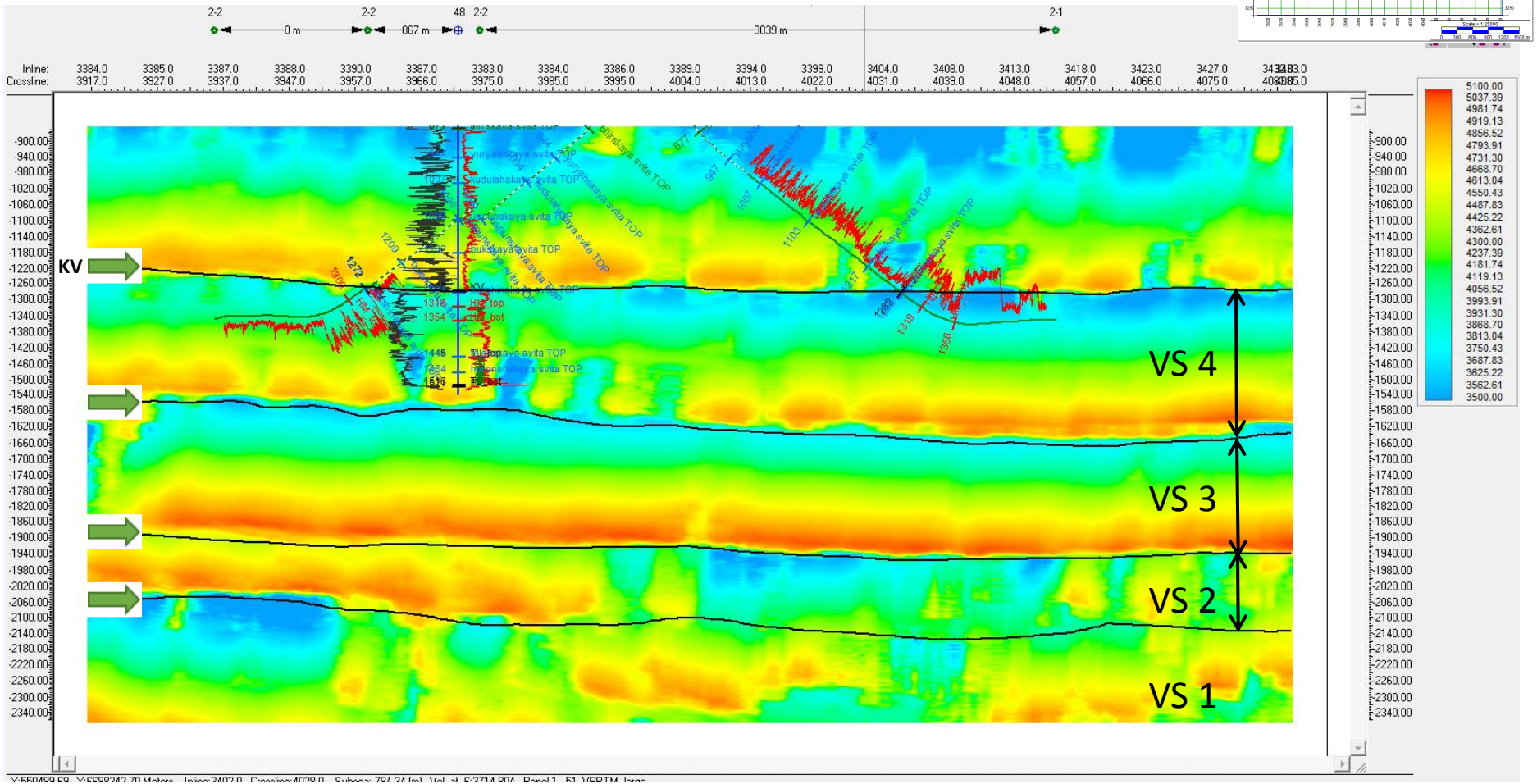




RTH-velocity scale, m / s

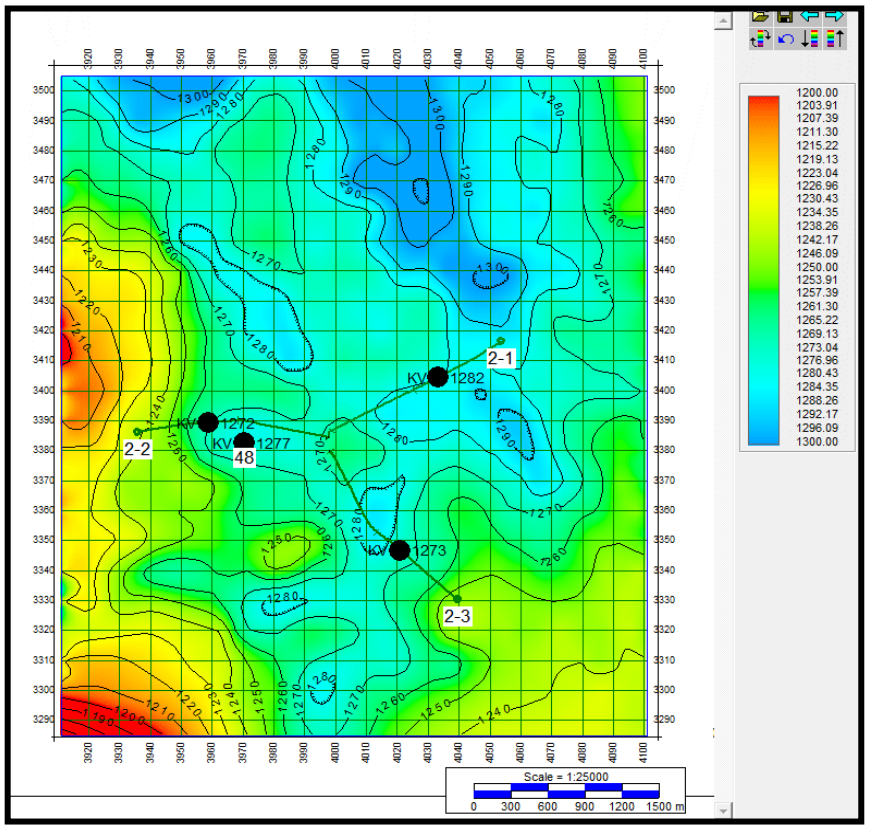
Georeferencing of the RTH-velocity cube according to well logging data



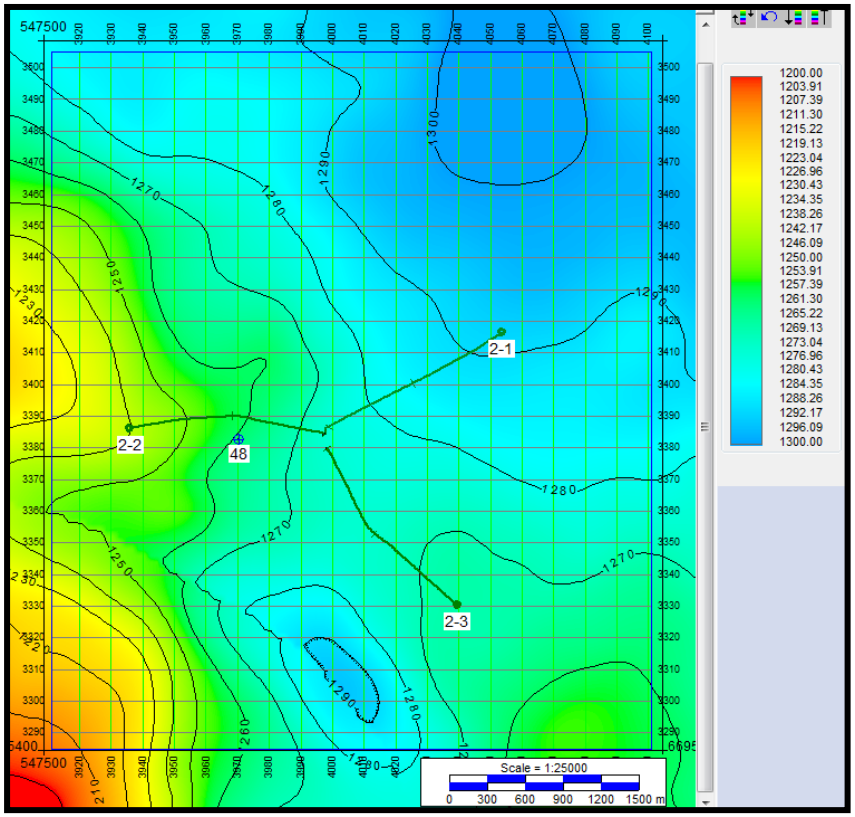


RTH-velocity scale, m / s

Comparison of KV horizon structural map constructed using the velocity-based RTH approach with the conventional PSDM structural map



RTH map, m



PSDM map, m

Well #	Depth, well (m)	Depth, RTH map (m)	Error (m)
48	1277	1272	5
2-1	1282	1280	2
2-2	1272	1271	1
2-3	1273	1274	1

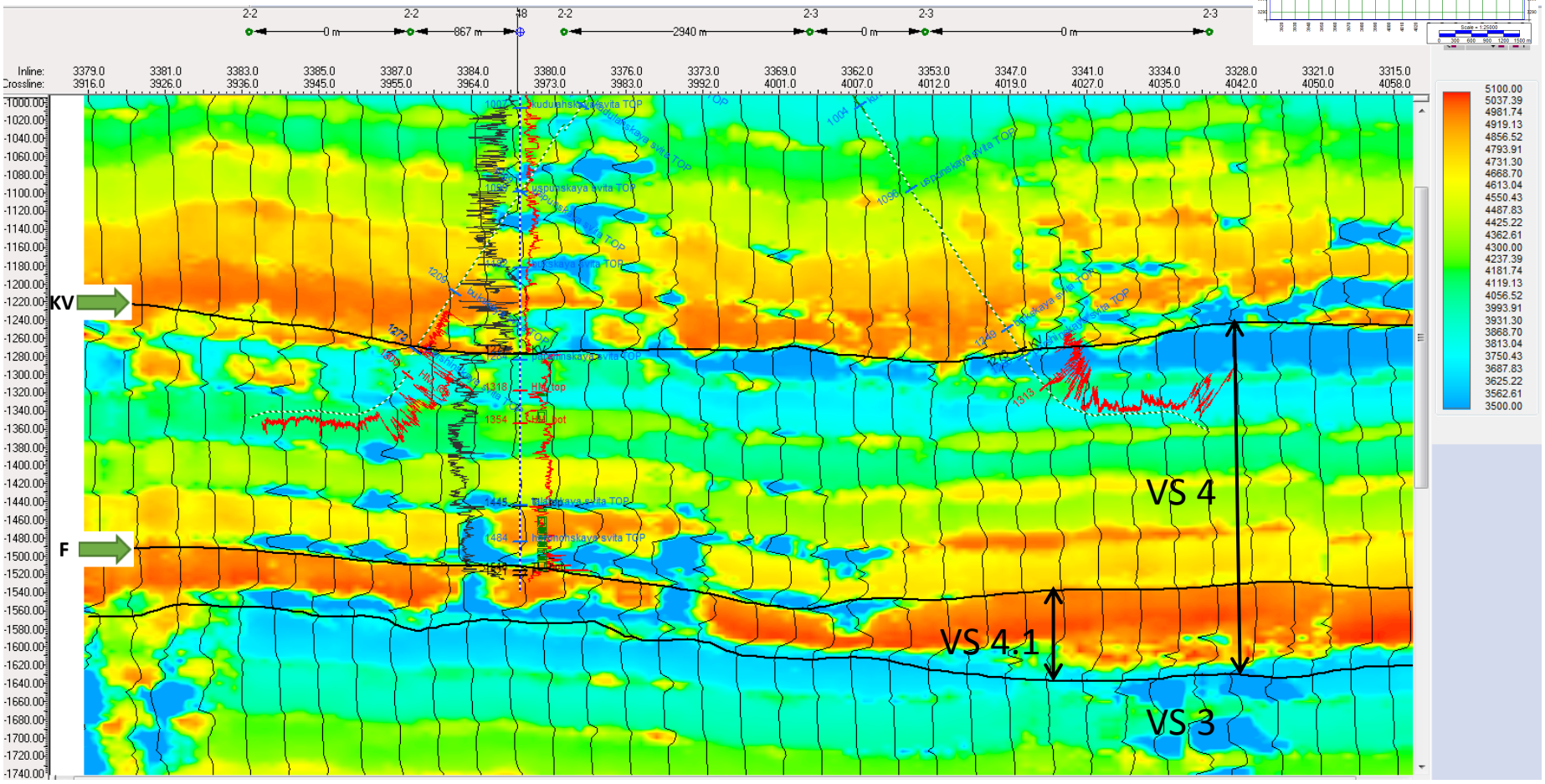
Black dots on the map -
KV's depth by inclinometry

RTH interpretation stages

Stage 3 **Identification of thinner RTH-velocity stratums, correlation of their boundaries using additional RTH attributes**

Identification of thinner RTH-velocity stratums inside VS 4

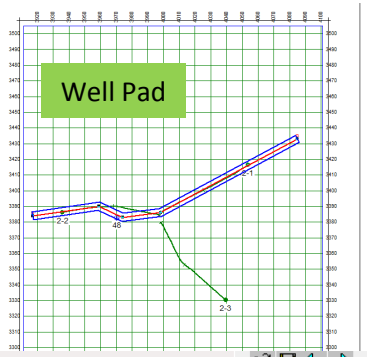
Top of VS 4.1 - foundation surface (F)

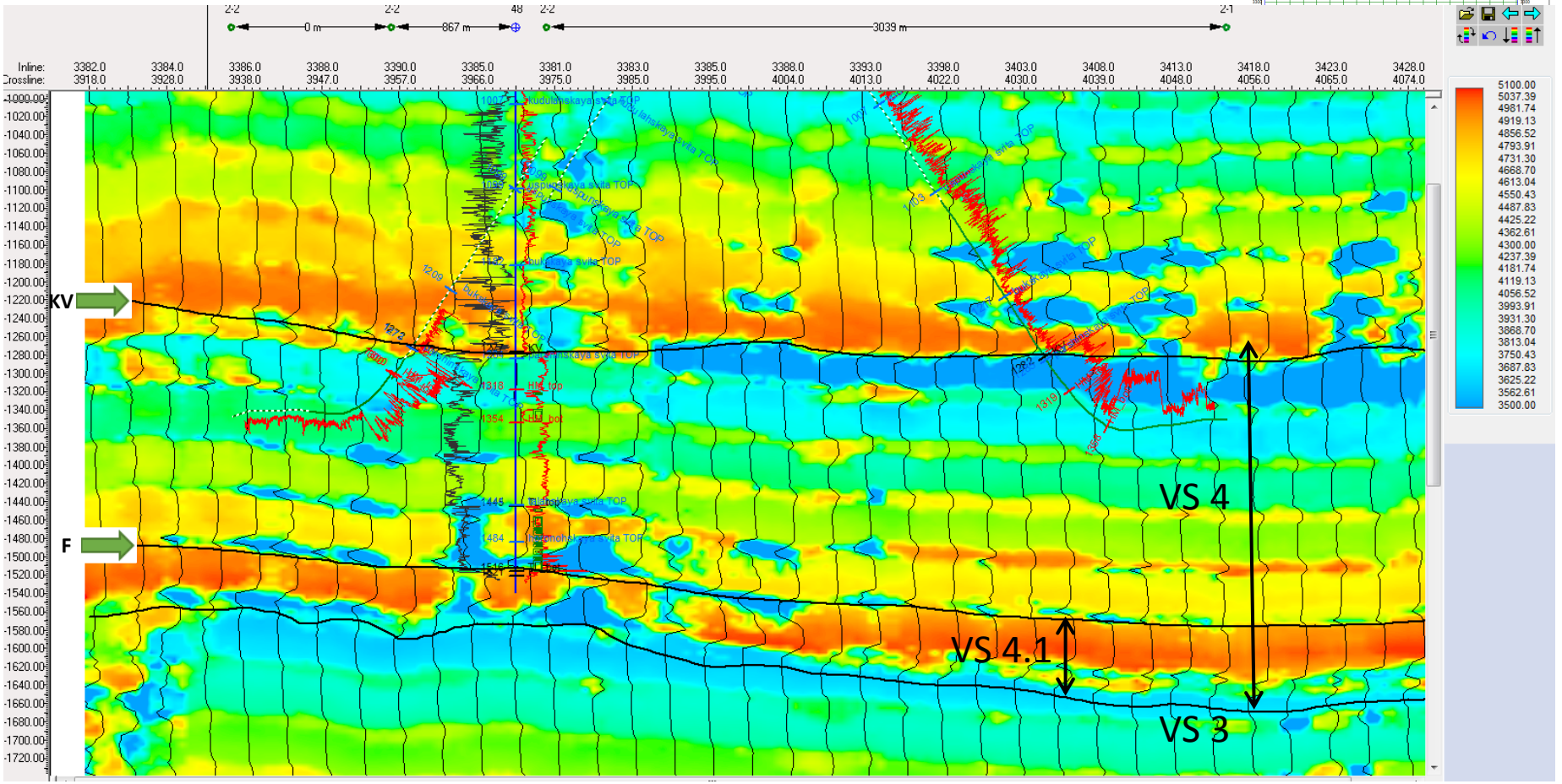


RTH-velocity scale, m / s. Wiggle - RTH-velocity

Identification of thinner RTH-velocity stratums inside VS 4

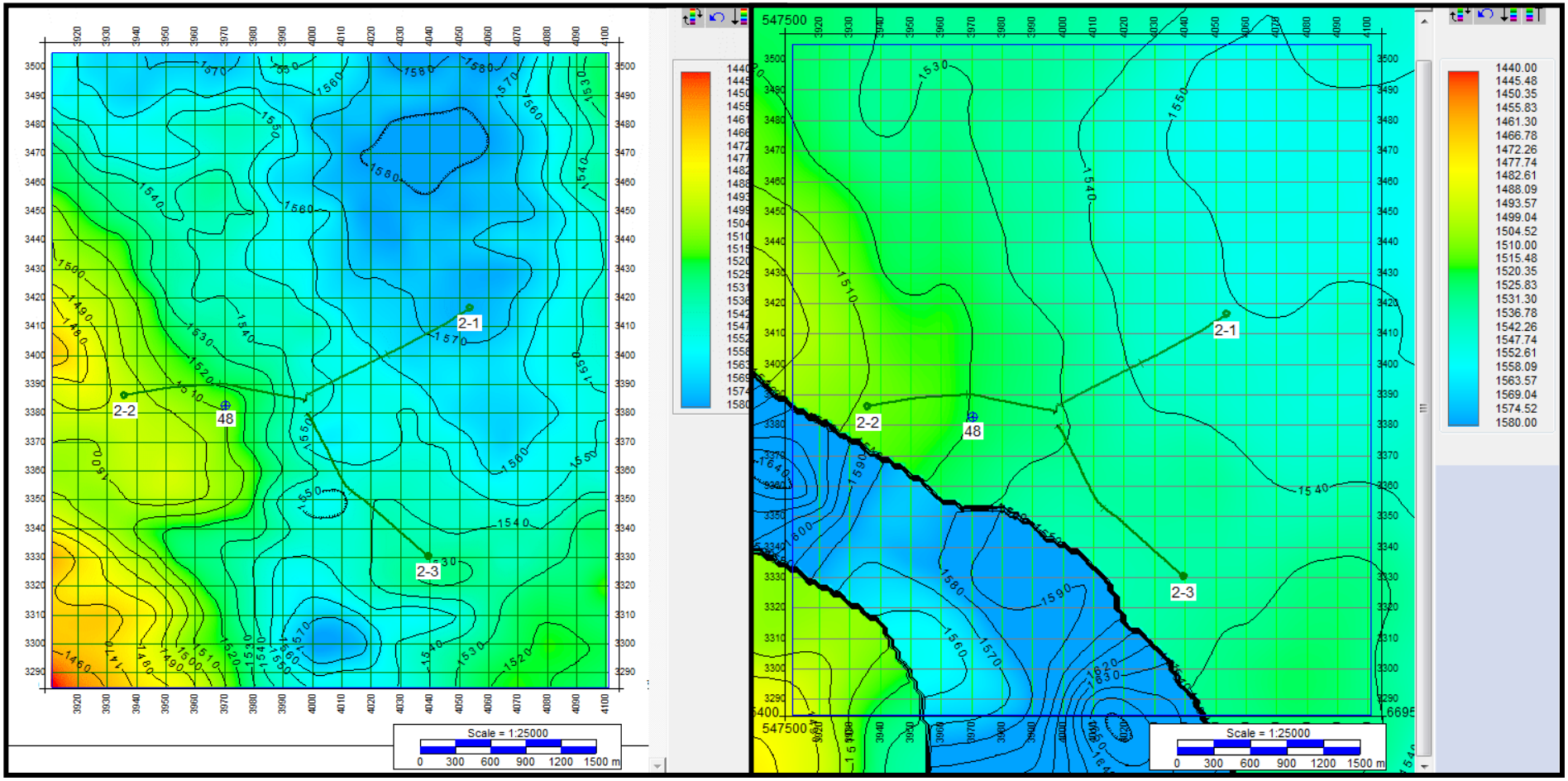
Top of VS 4.1 is the foundation surface (F)





RTH-velocity scale, m / s. Wiggle - RTH-velocity

Comparison of F horizon structural map constructed using the velocity-based RTH approach with the conventional PSDM structural map

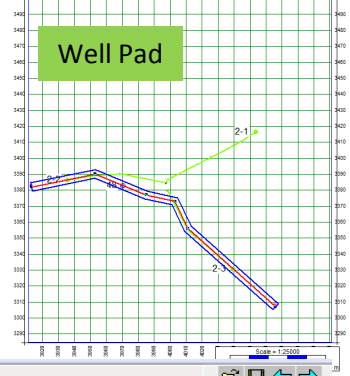


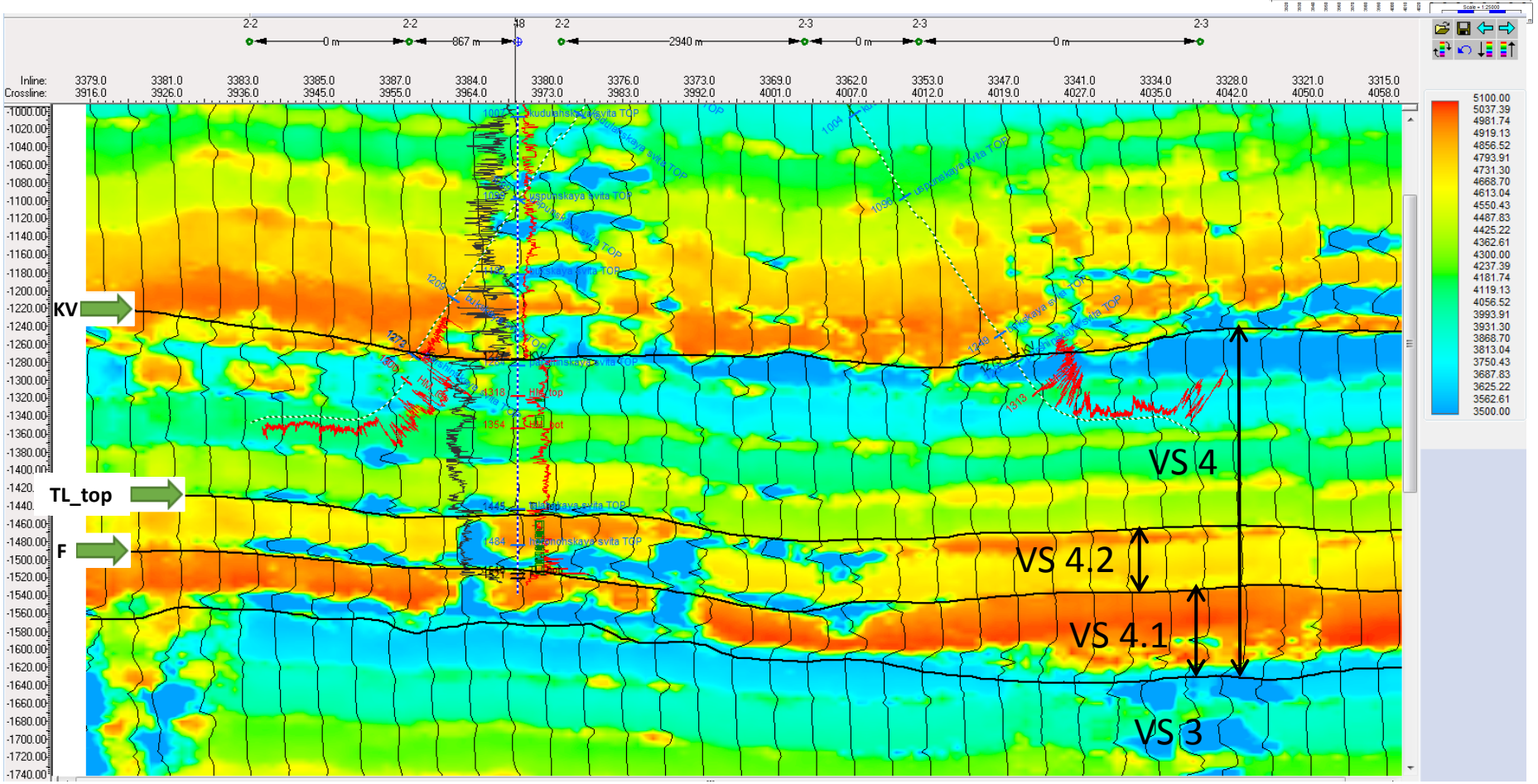
RTH map, m

PSDM map, m

Identification of thinner RTH-velocity stratums inside VS 4

Top of VS 4.2 is the top of Talakh horizon (TL)

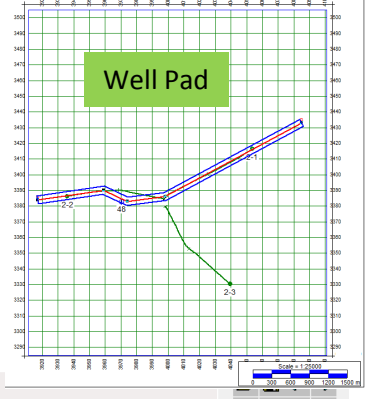




RTH-velocity scale, m / s. Wiggle - RTH-velocity

Identification of thinner RTH-velocity stratums inside VS 4

Top of VS 4.2 is the top of Talakh horizon (TL)



KV

TL_top

F

VS 4

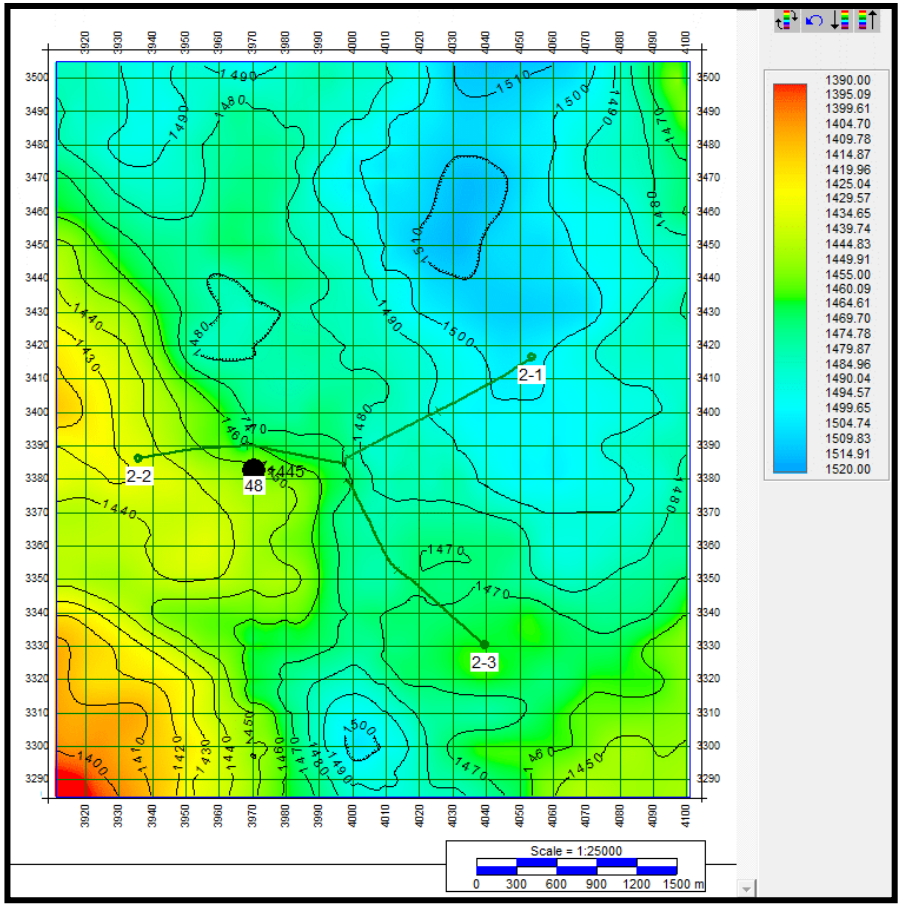
VS 4.2

VS 4.1

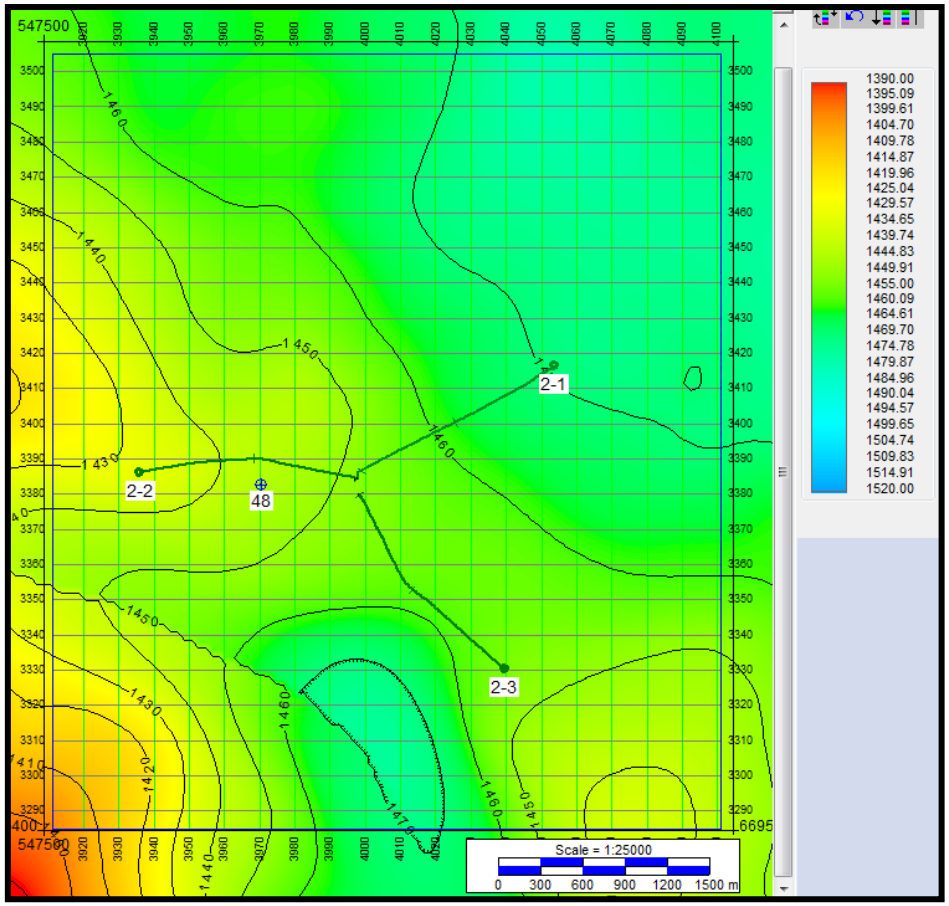
VS 3

RTH-velocity scale, m / s. Wiggle - RTH-velocity

Comparison of TL horizon structural map constructed using the velocity-based RTH approach with the conventional PSDM structural map



RTH map, m

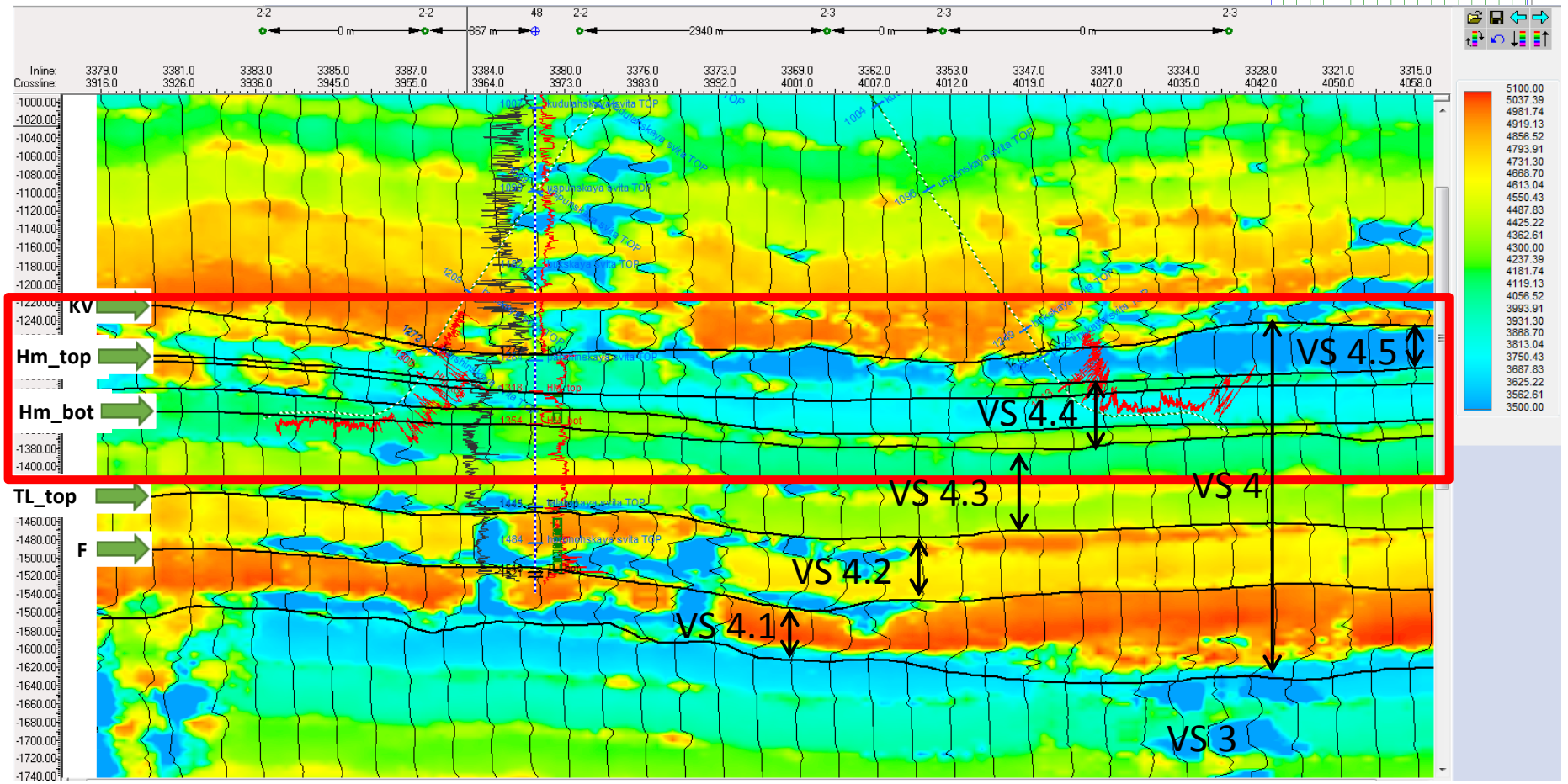


PSDM map, m

Well #	Depth, well (m)	Depth, RTH map (m)	Error (m)
48	1445	1450	5

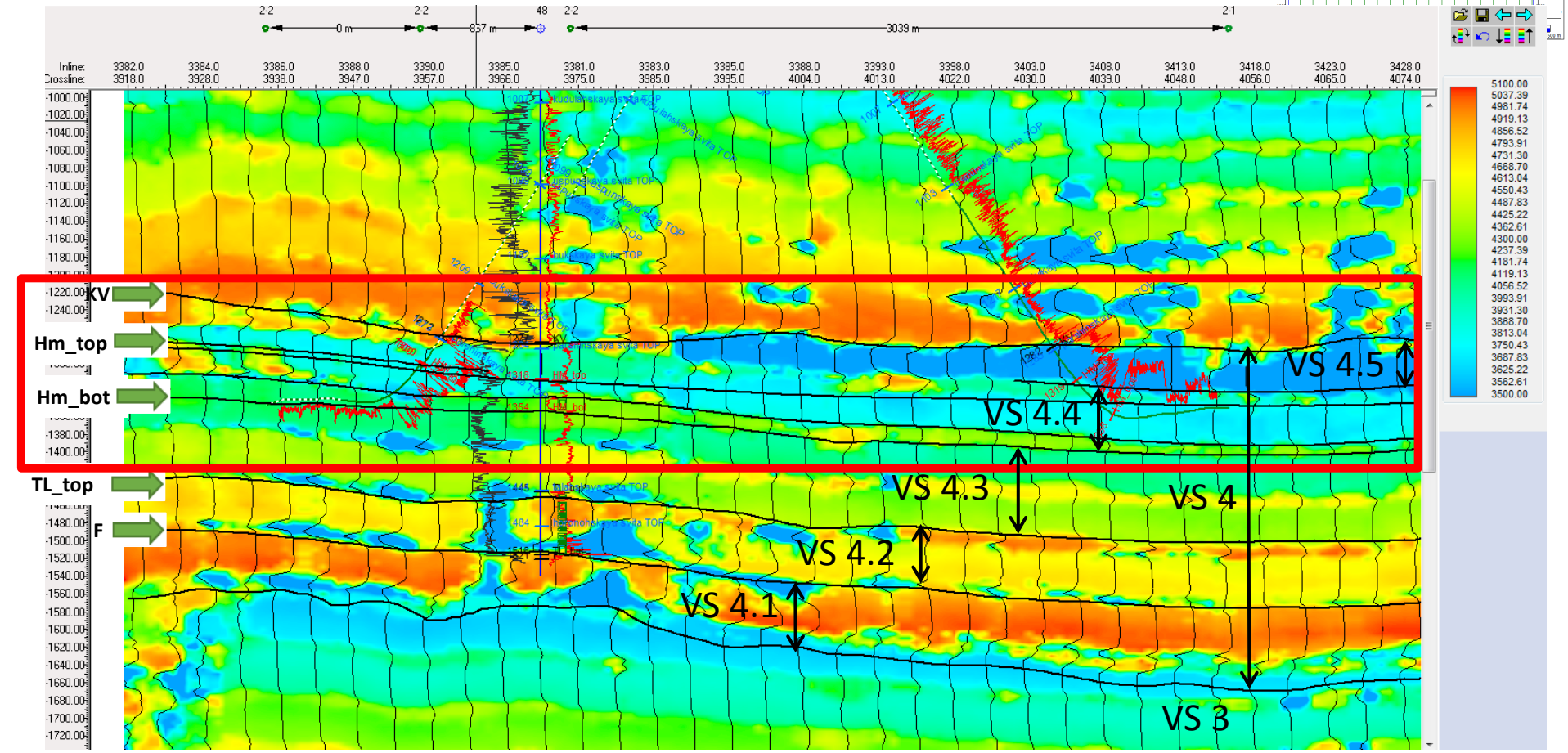
Black dots on the map -
TL's depth by inclinometry

Identification of thinner RTH stratums, the upper boundaries of which coincide with the following stratigraphic horizons (from top to bottom): KV, Hm_top, Hm_bot, Tl_top, F



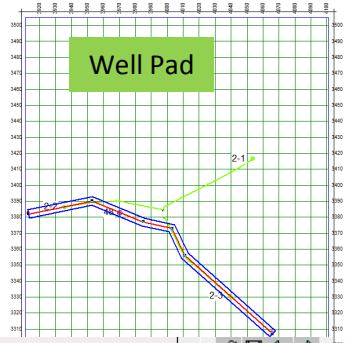
RTH-velocity scale, m / s. Wiggle - RTH-velocity

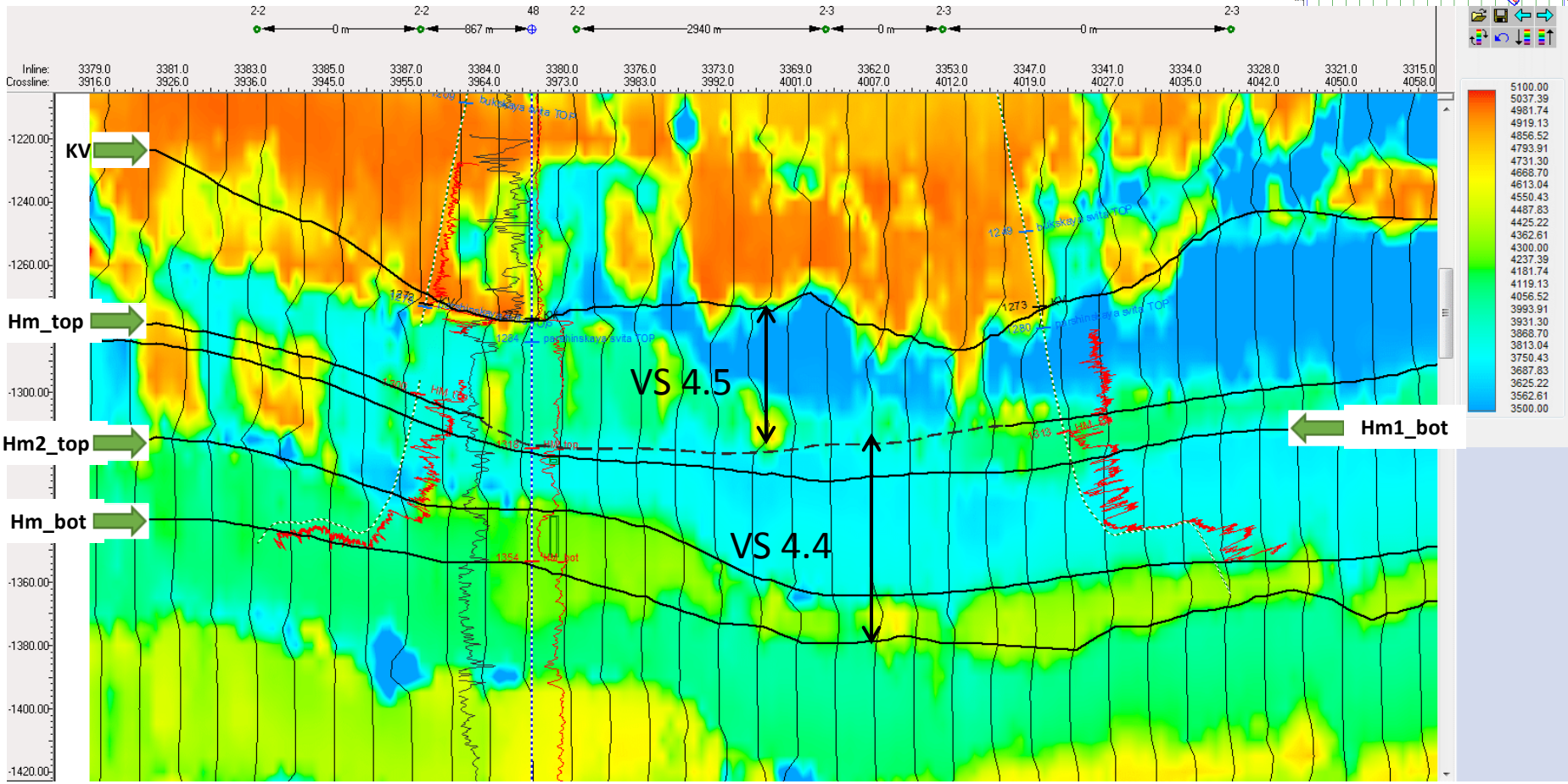
Identification of thinner RTH stratums, the upper boundaries of which coincide with the following stratigraphic horizons (from top to bottom): KV, Hm_top, Hm_bot, Tl_top, F



RTH-velocity scale, m / s. Wiggle - RTH-velocity

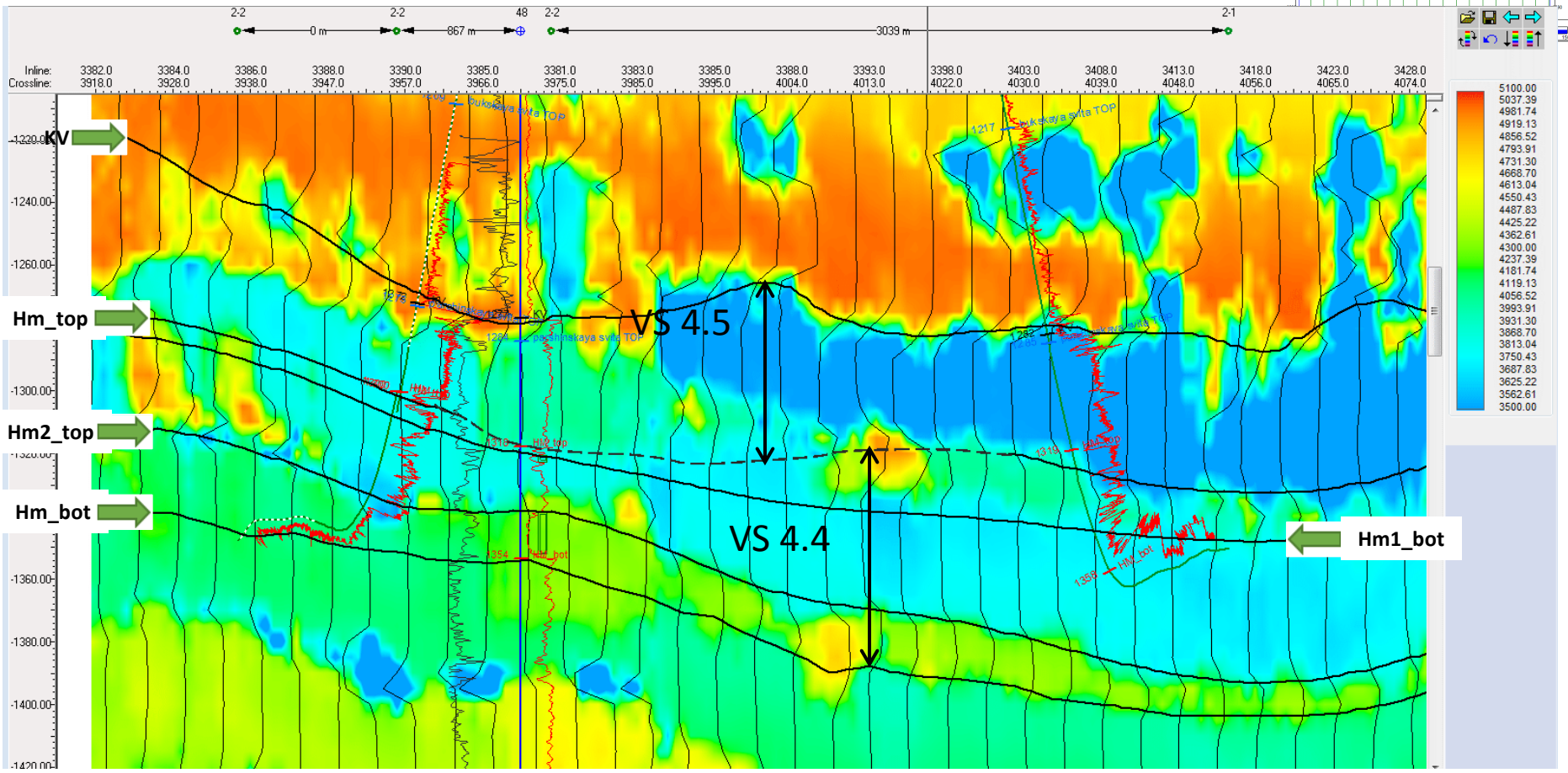
Dismemberment of the productive Khamakinsky horizon (Hm) into upper (Hm1) and lower (Hm2) subhorizons





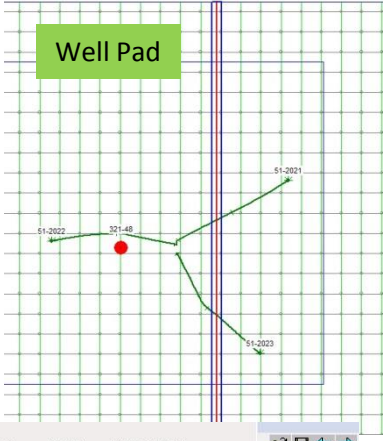
RTH-velocity scale, m / s. Wiggle - RTH-velocity

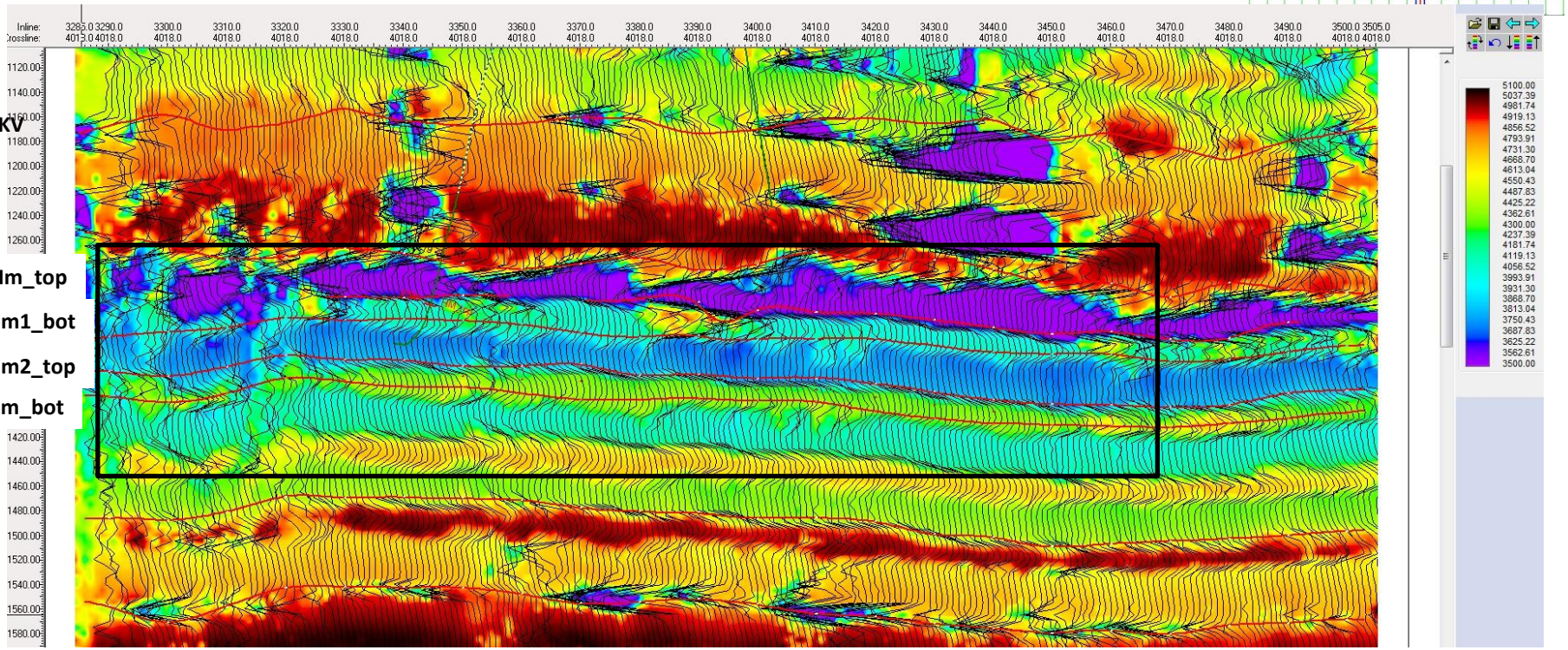
Dismemberment of the productive Khamakinsky horizon (Hm) into upper (Hm1) and lower (Hm2) subhorizons



RTH-velocity scale, m / s. Wiggle - RTH-velocity

About spatial resolution of the RTH method. Cross line RTH-velocity example

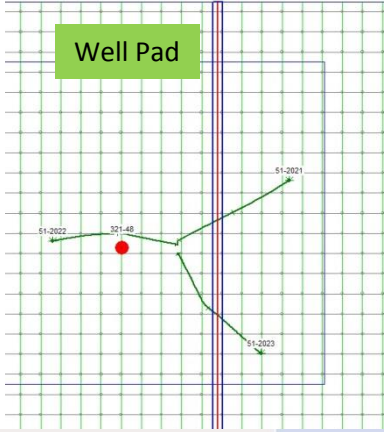


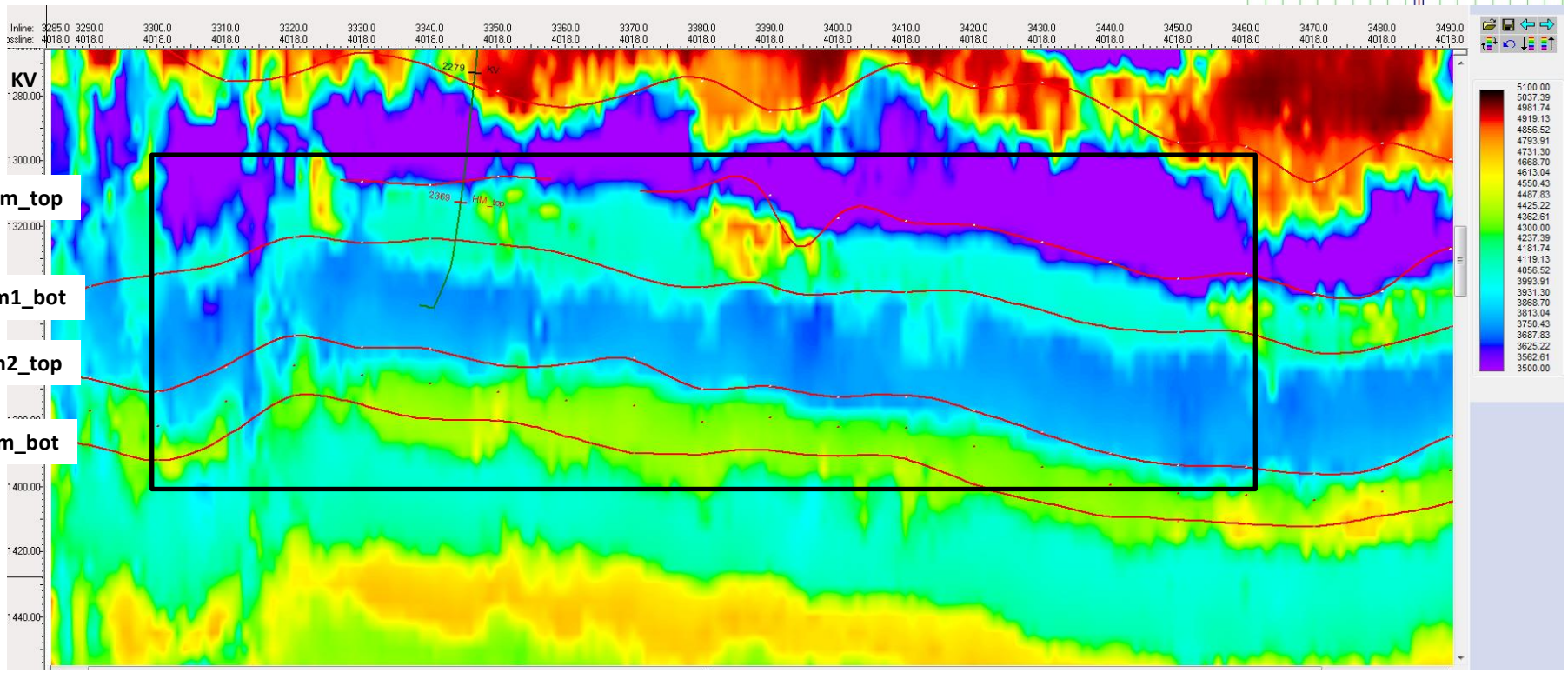


RTH-velocity scale, m / s. Wiggle - RTH-velocity

About spatial resolution of the RTH method. Cross line RTH-velocity example

Zooming black box from previous slide

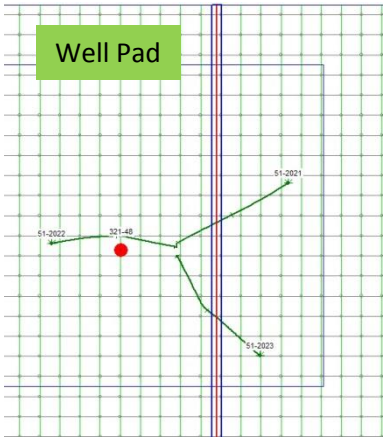


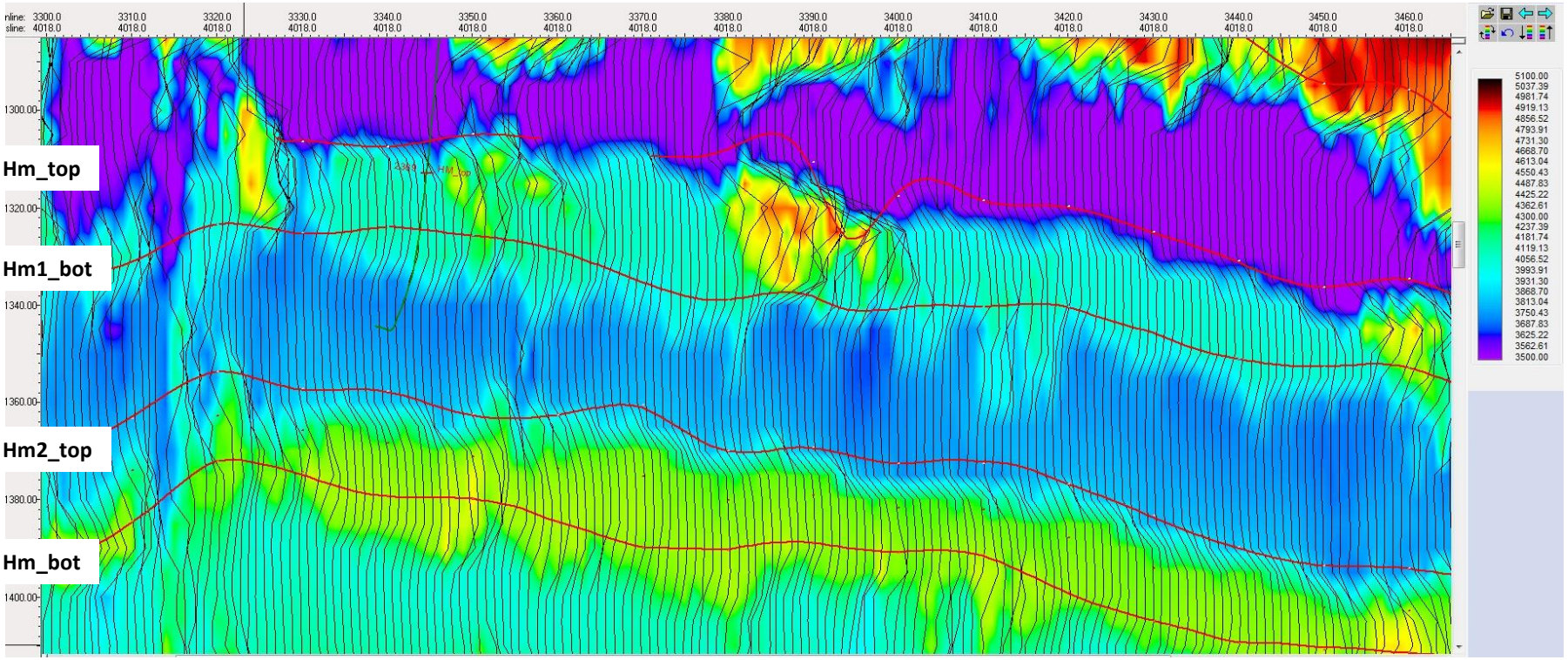


RTH-velocity scale, m / s

About spatial resolution of the RTH method. Cross line RTH-velocity example

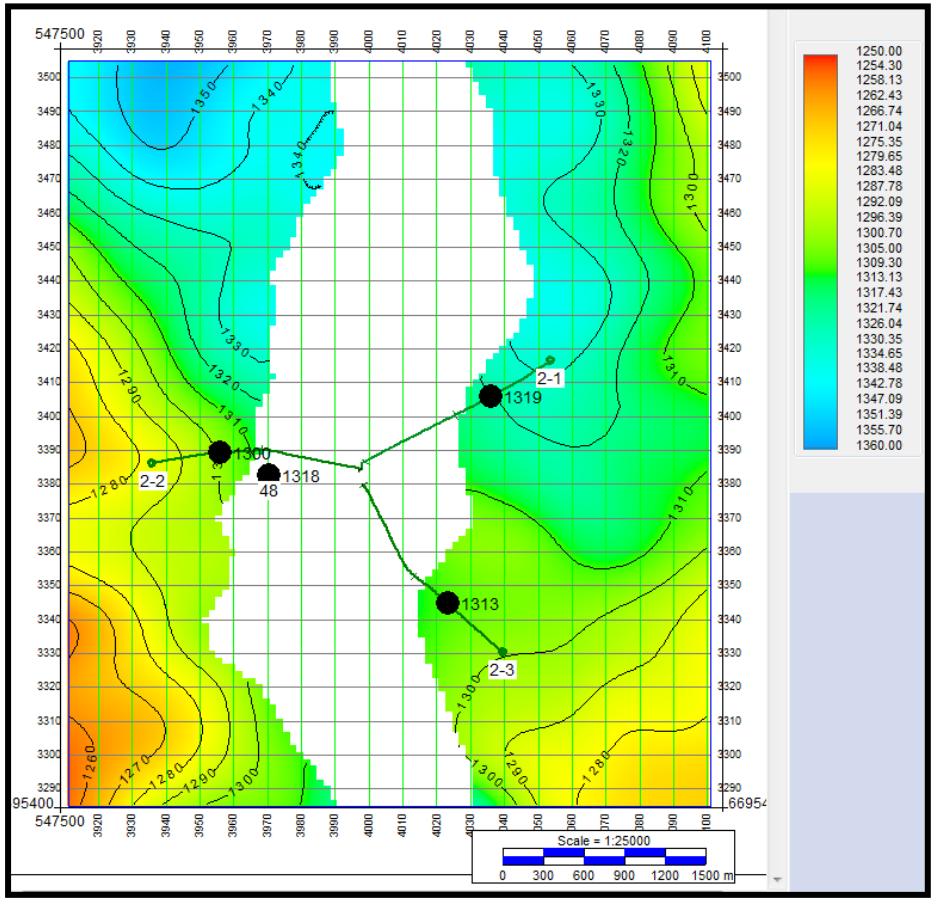
Zoom black box from previous slide



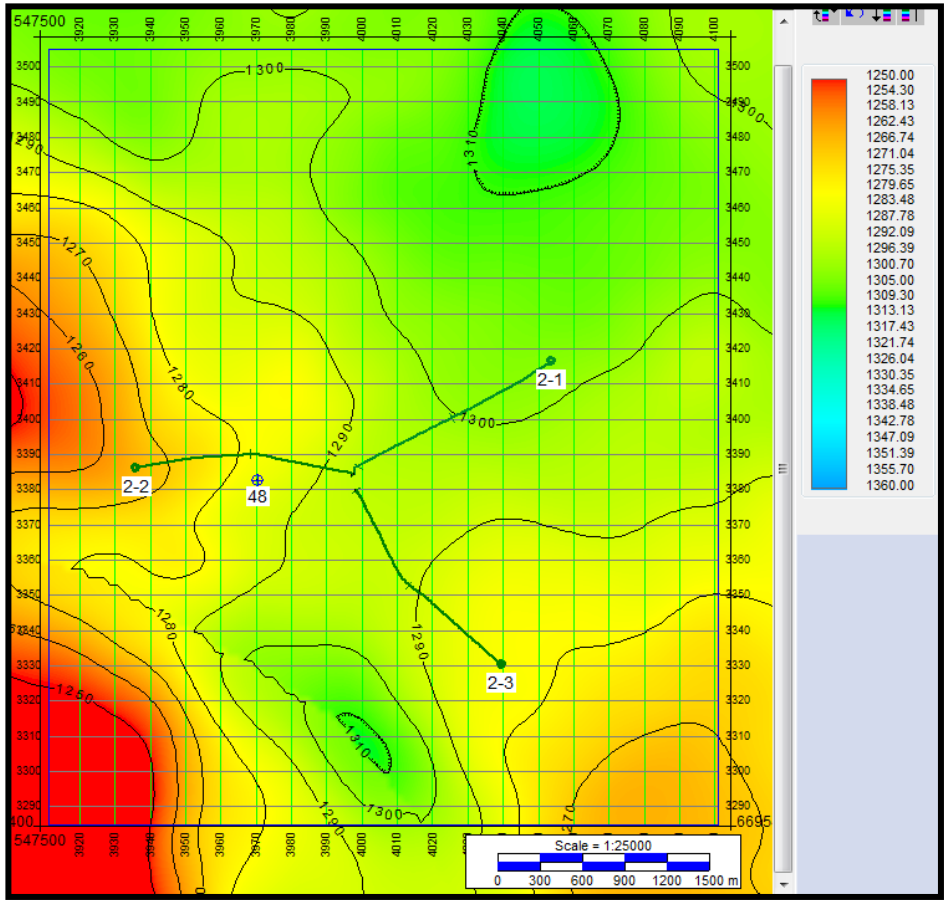


RTH-velocity scale, m / s. Wiggle - RTH-velocity

Comparison of Hm_top horizon structural map constructed using the velocity-based RTH approach with the conventional PSDM structural map



RTH map, m

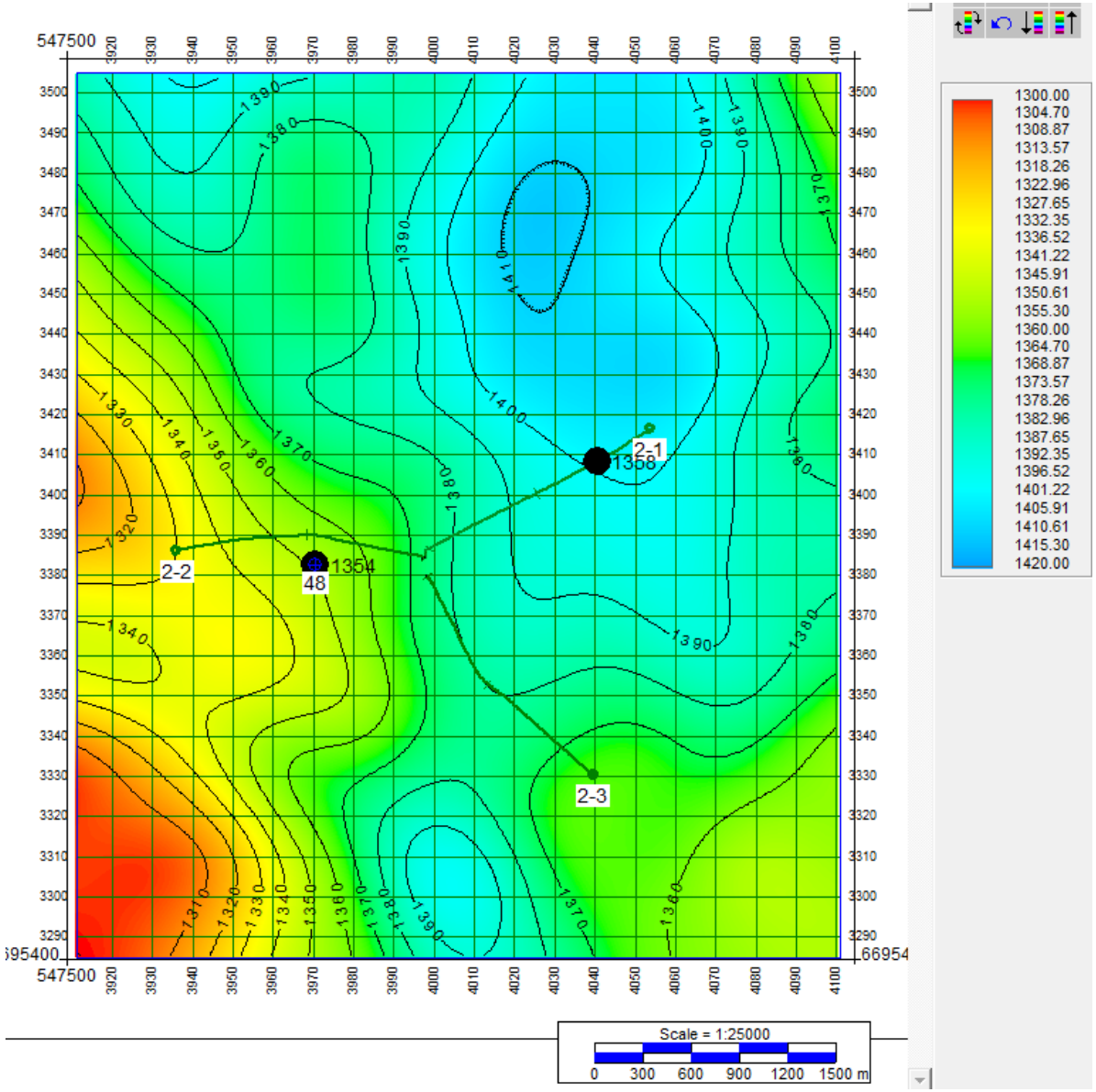


PSDM map, m

Well #	Depth, well (m)	Depth, RTH map (m)	Error (m)
48	1318	-	
2-1	1319	1220	1
2-2	1300	1300	0
2-3	1313	1308	5

Black dots on the map -
Hm_top's depth by inclinometry

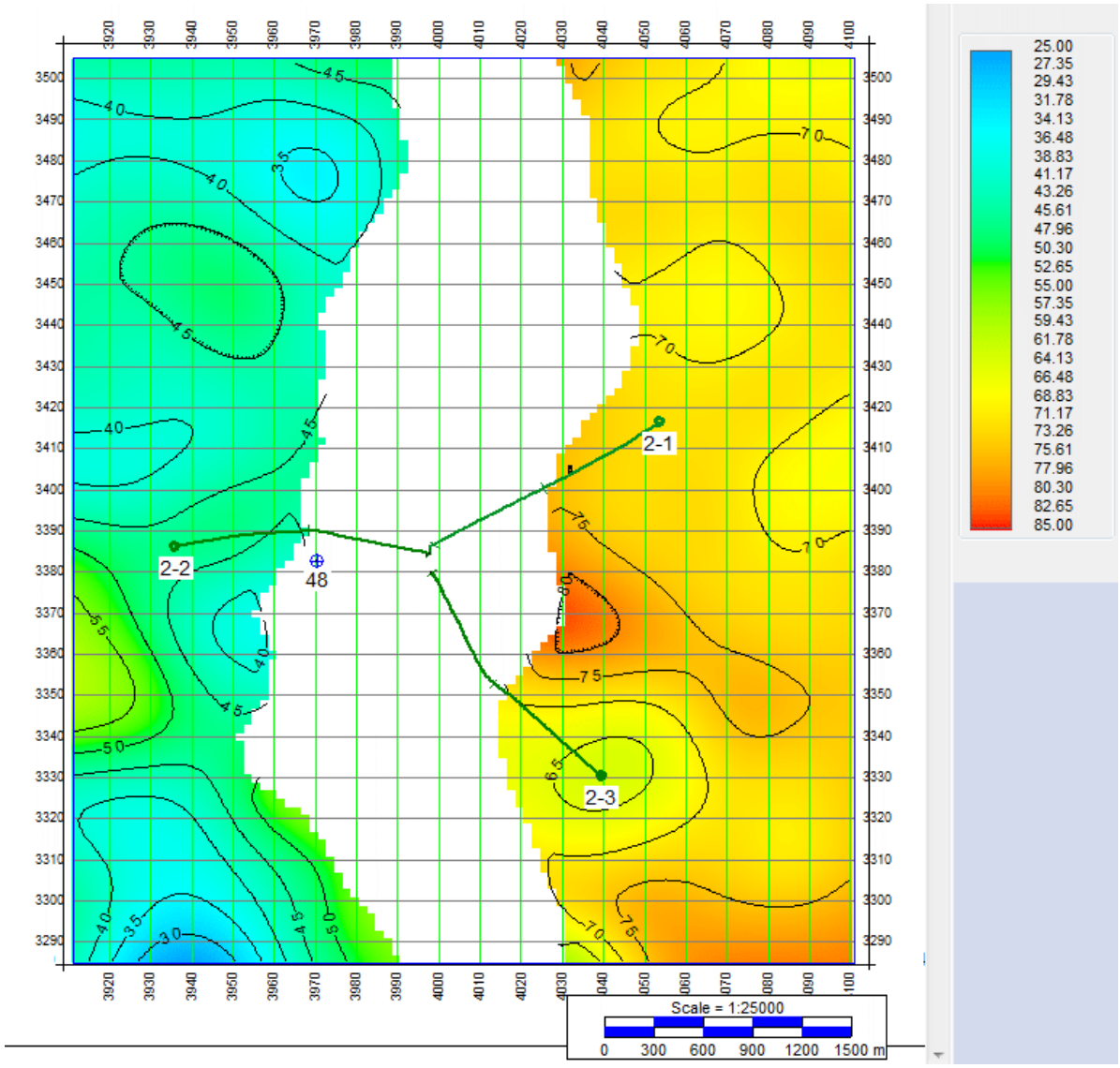
Structural map of the base of the Khamakinsky horizon (Hm_bot)



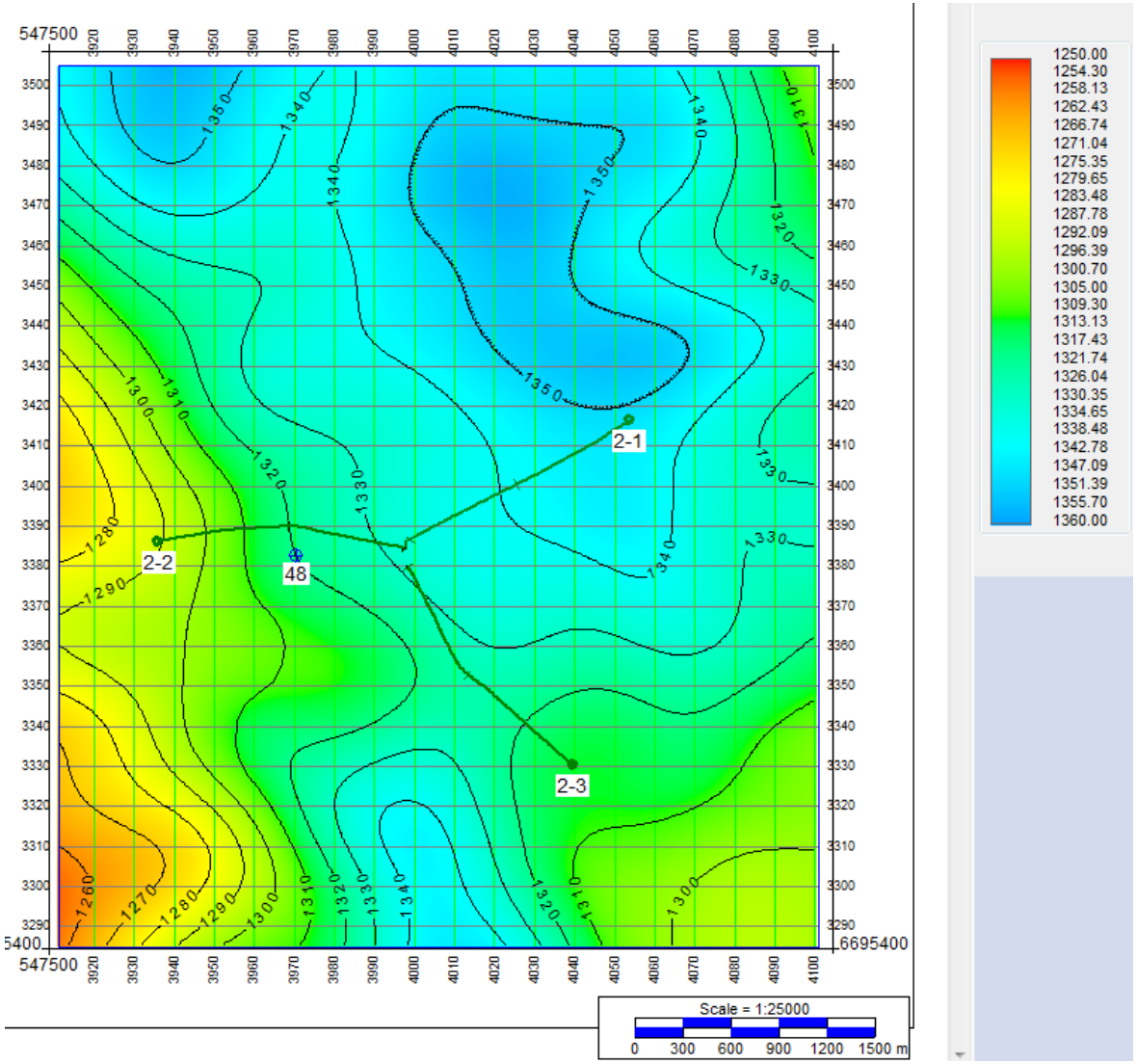
Black dots on the map -
Hm_top's depth by inclinometry

RTH map, m

Thickness map of the Khamakinsky horizon (Hm_top- Hm_bot), meters

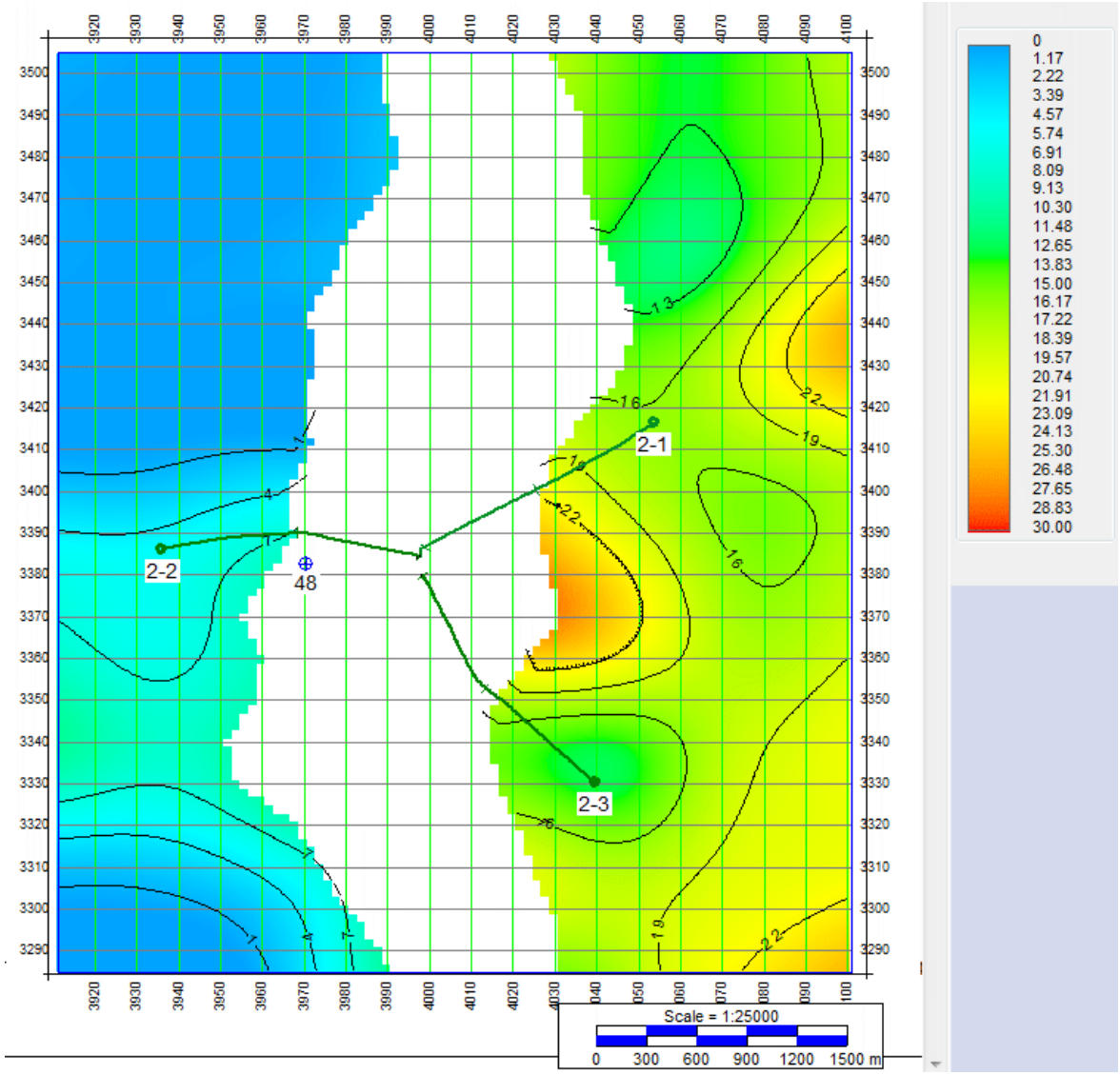


Structural map of the base of the upper Khamakinsky subhorizon (Hm1_bot)

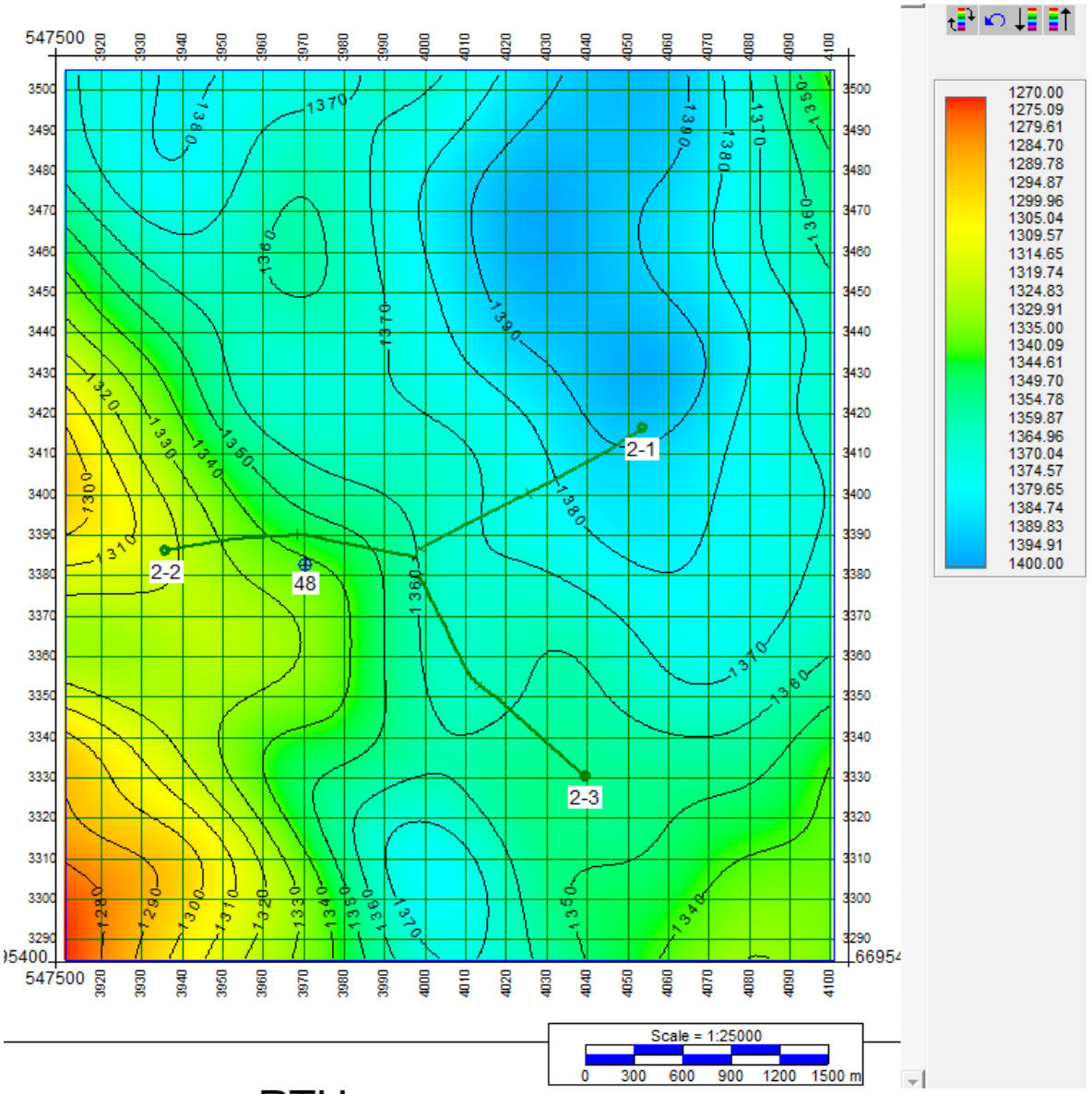


RTH map, m

Thickness map of the upper subhorizon (Hm1) of the Khamakinsky horizon (Hm_top- Hm1_bot), meters

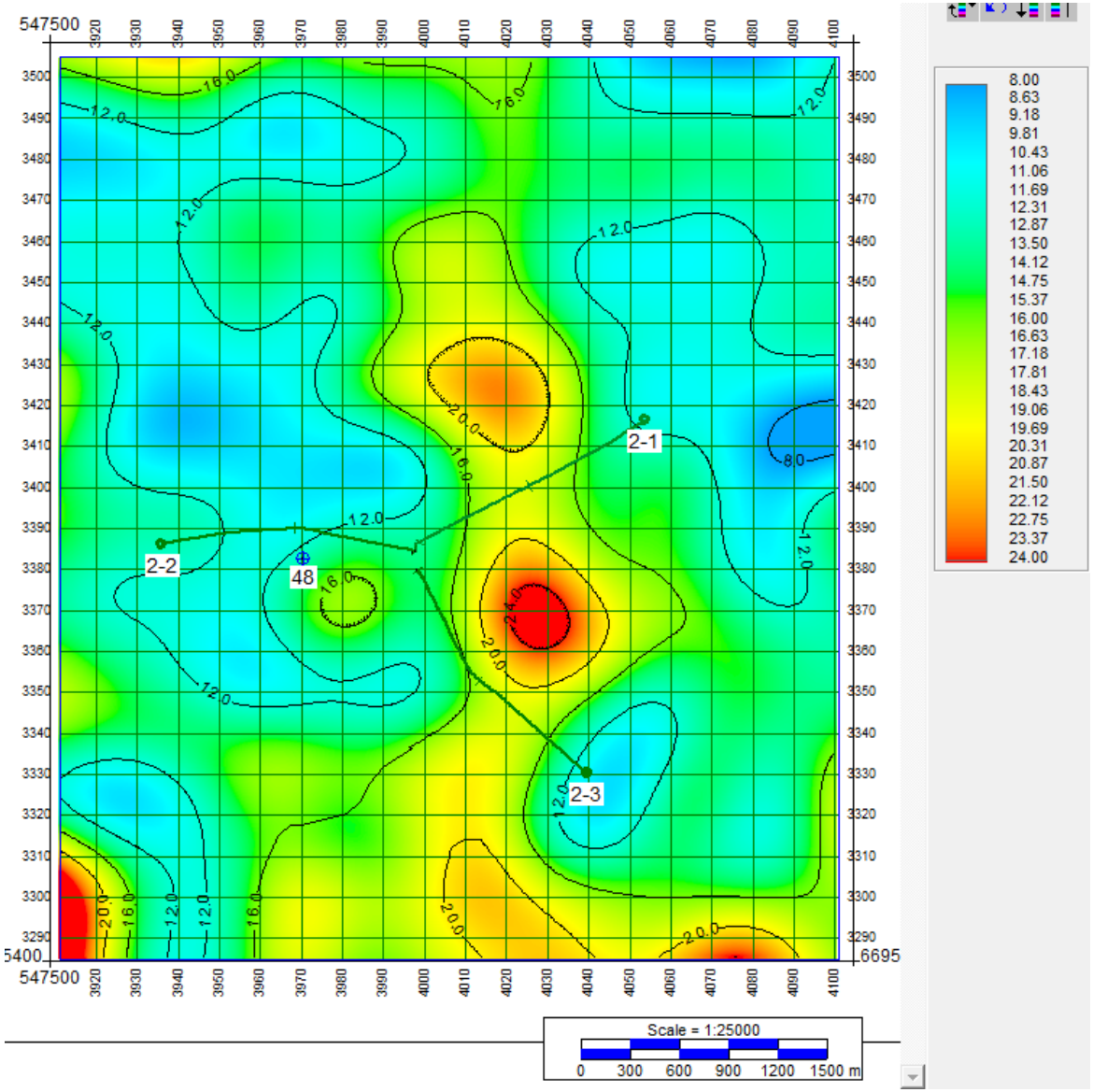


Structural map of the base of the lower Khamakinsky subhorizon (Hm1_bot)



RTH map, m

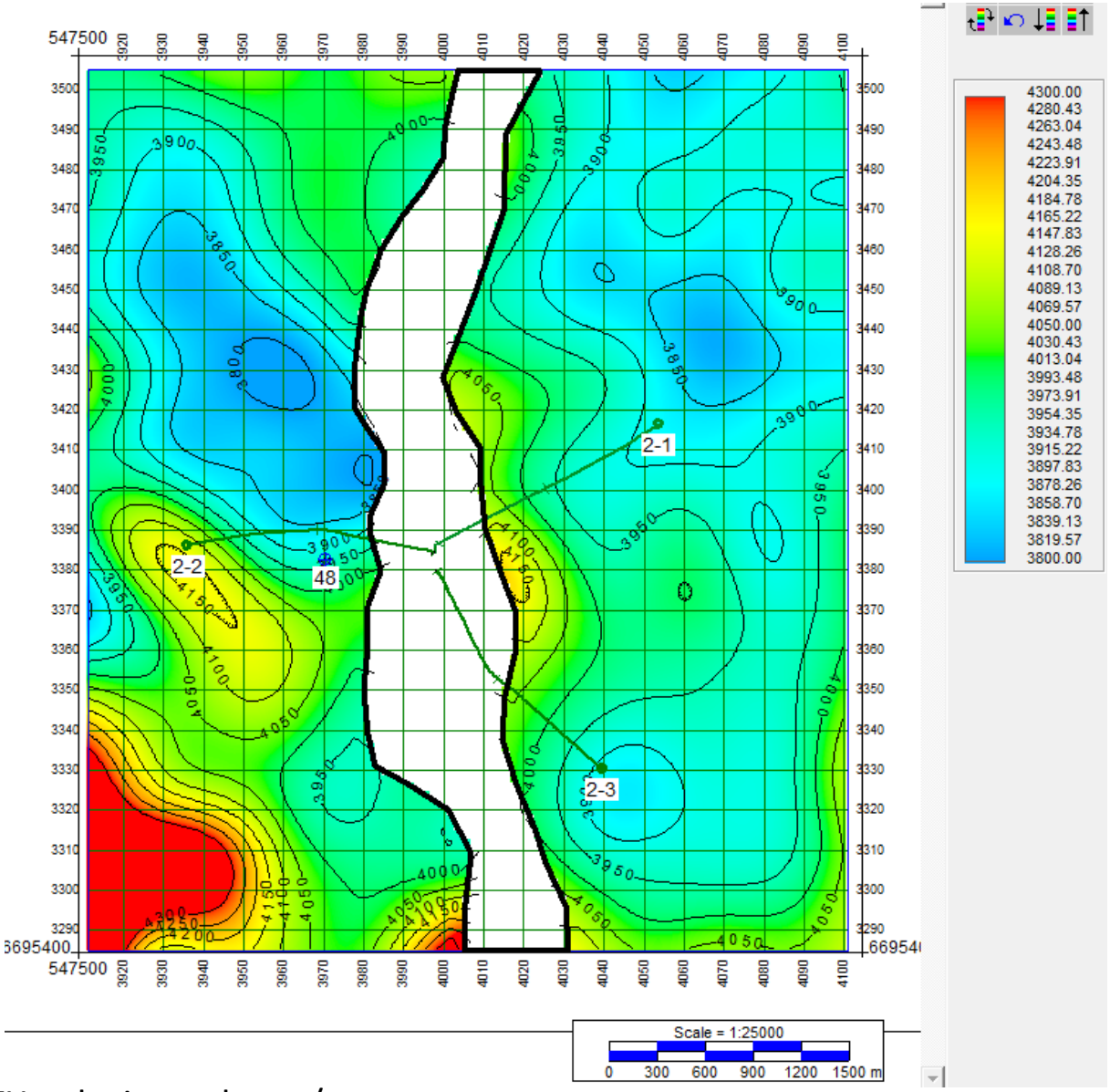
Thickness map of the lower subhorizon (Hm2) of the Khamakinsky horizon (Hm2_top- Hm_bot), meters



RTH interpretation stages

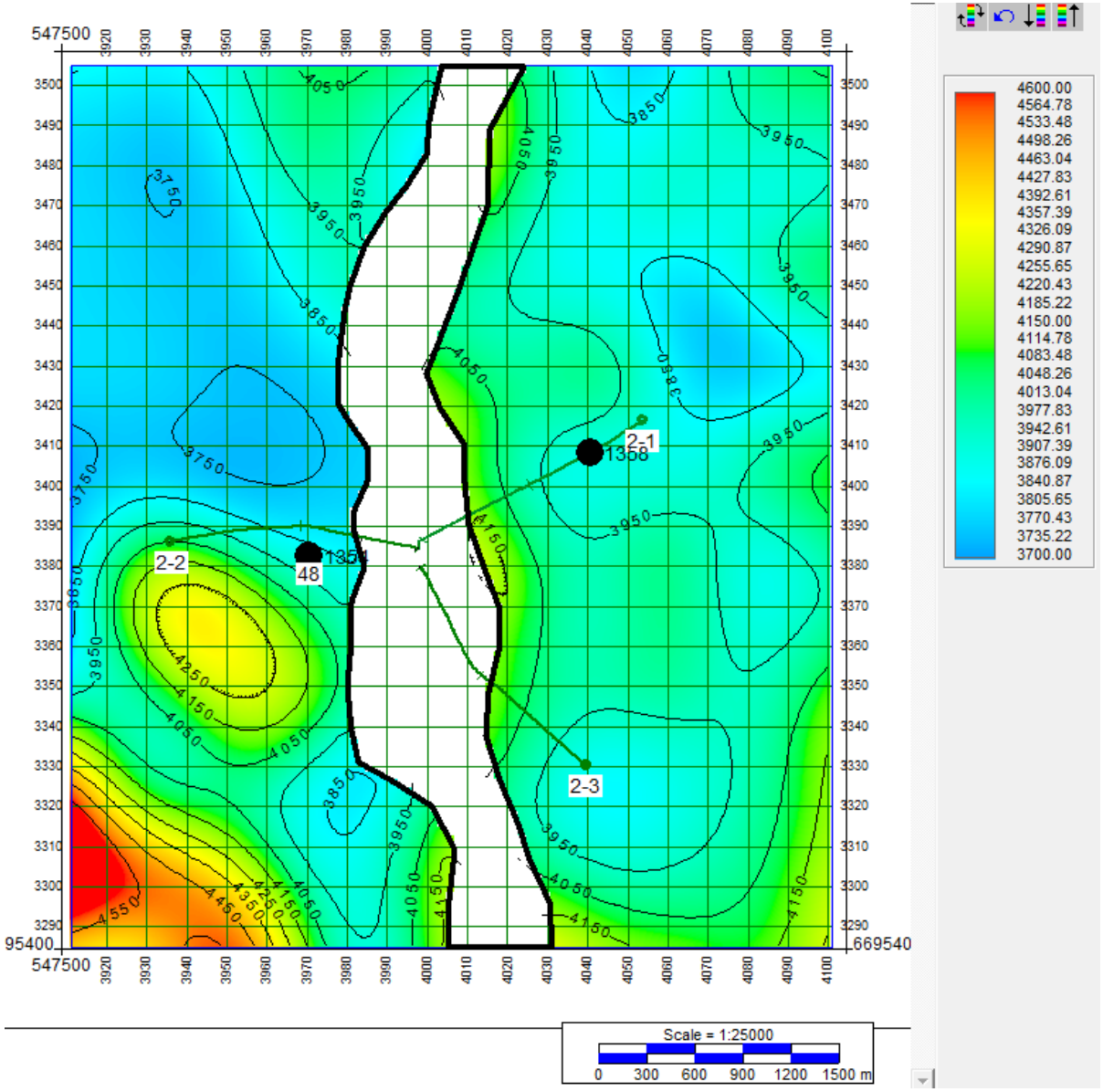
Stage 4 **Creation and analysis of maps of velocity and other attributes in the target productive intervals of the geological section**

RTH-velocity in the Khamakinsky horizon



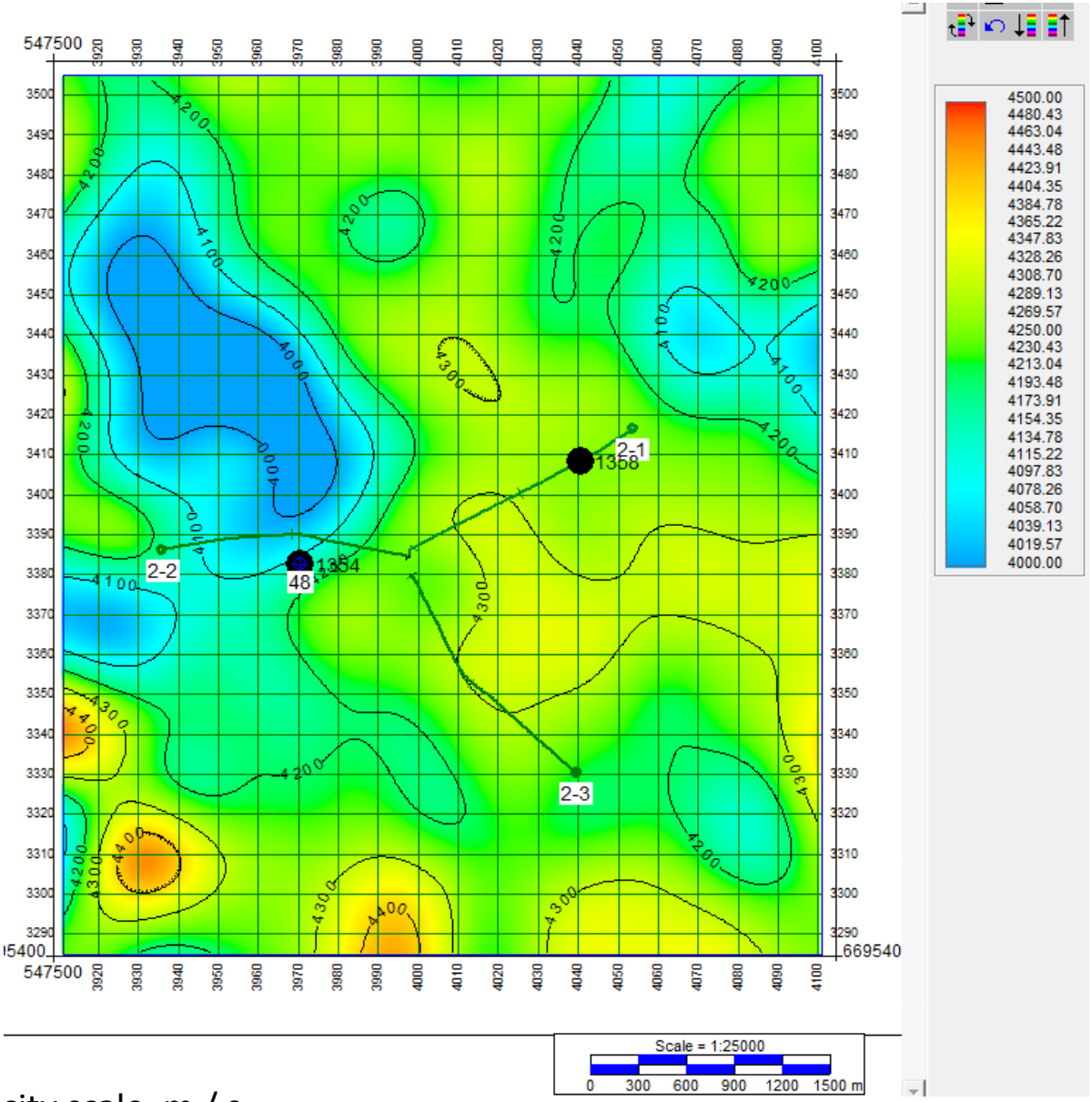
RTH-velocity scale, m / s

RTH-velocity in the upper Khamakinsky subhorizon (Hm1)



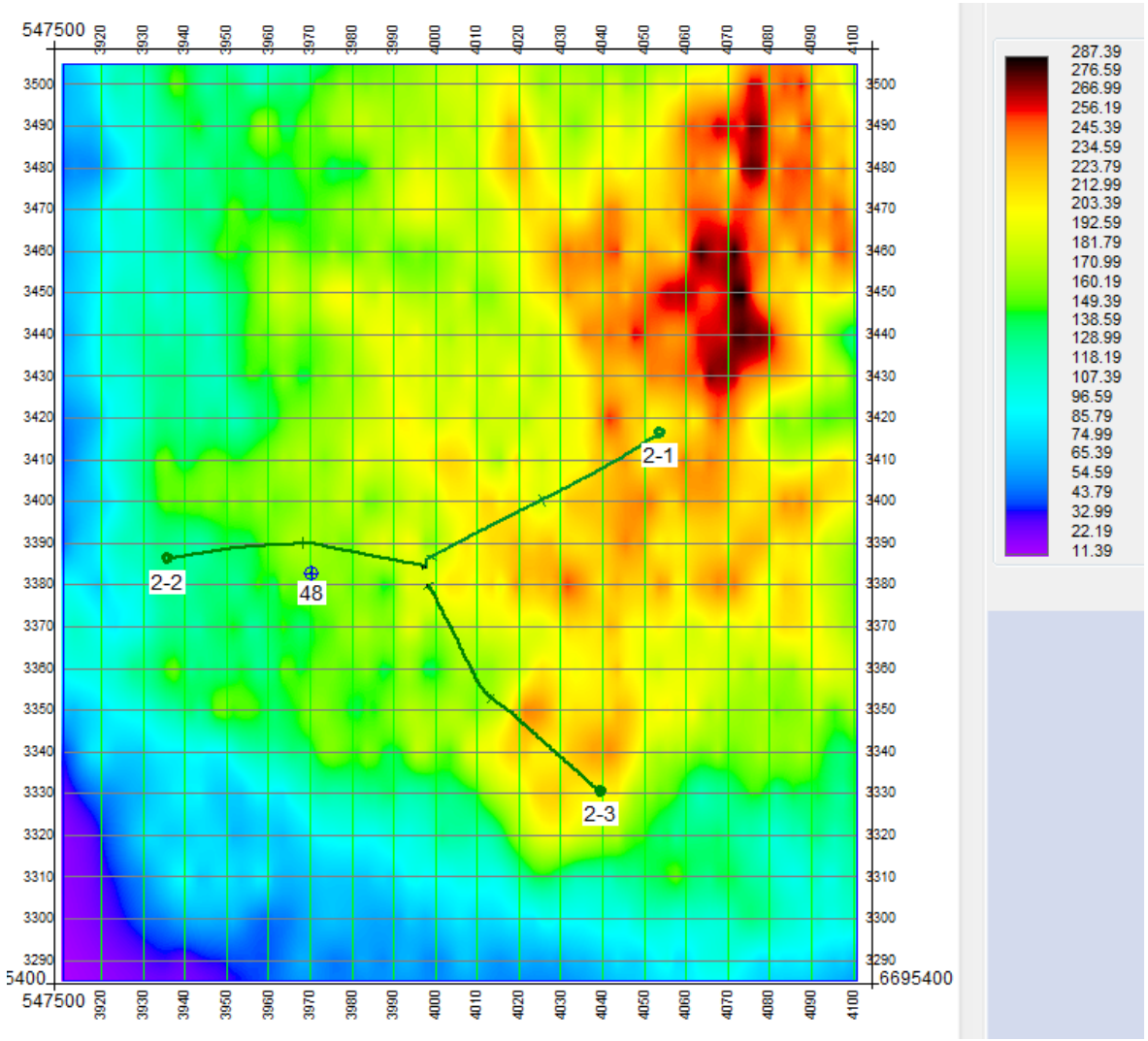
RTH-velocity scale, m / s

RTH-velocity in the lower Khamakinsky subhorizon (Hm2)



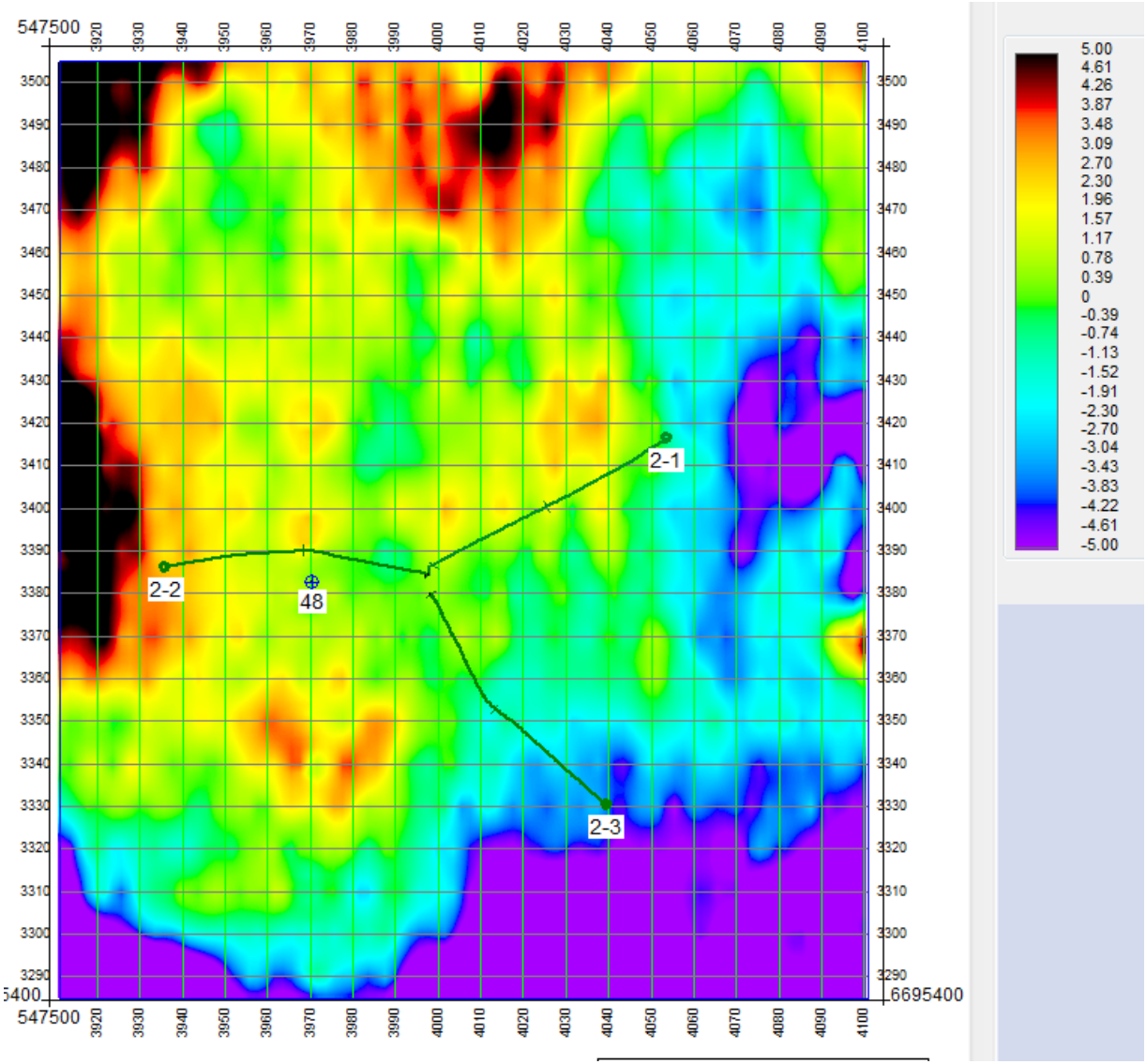
RTH-velocity scale, m / s

Diffractivity attribute in the lower Khamakinsky subhorizon (Hm2)



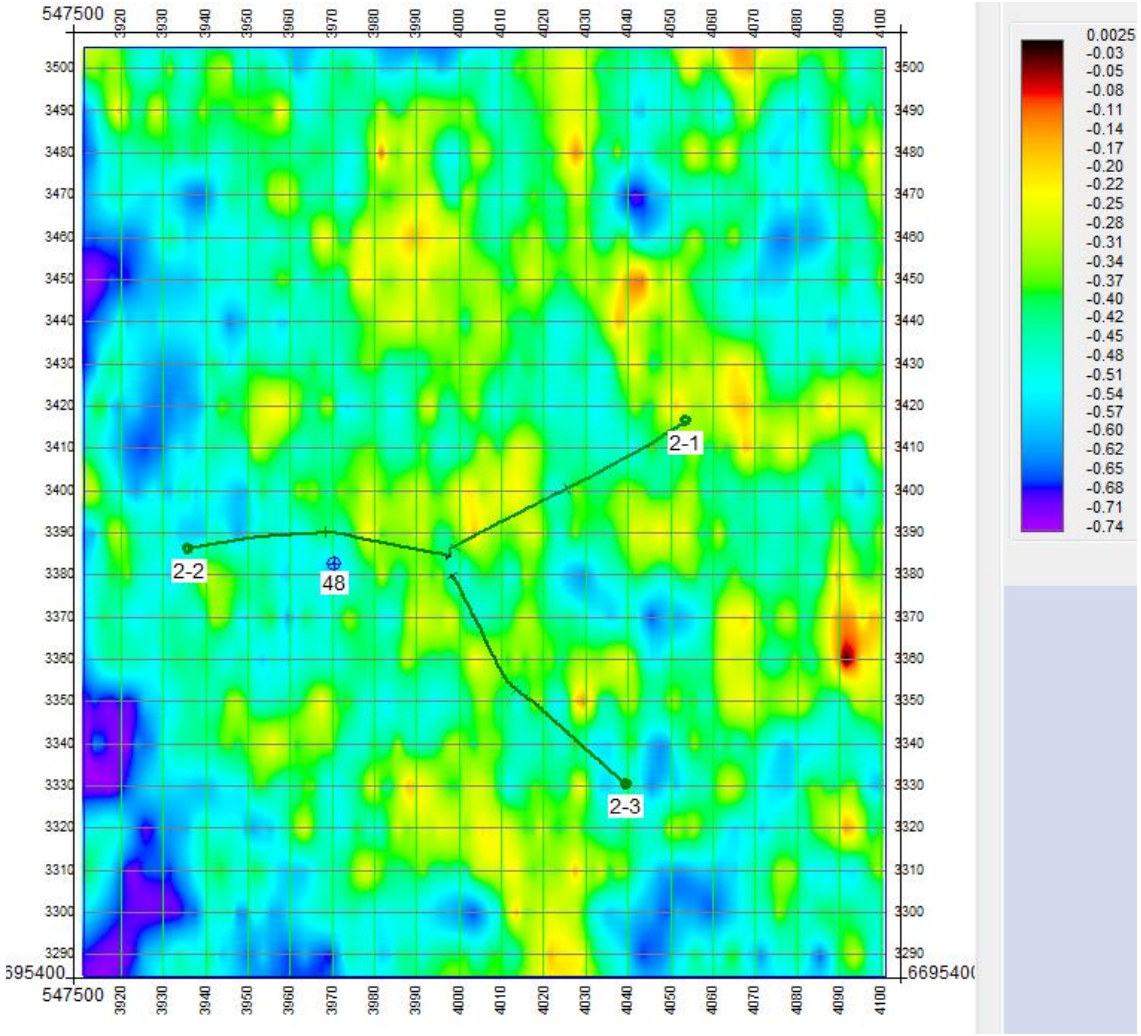
Diffractivity scale, relative units

Zenith Angle attribute in the lower Khamakinsky subhorizon (Hm2)



Zenith Angle scale, degree

Opening & Dip Angles Correlation attribute in the lower Khamakinsky subhorizon (Hm2)

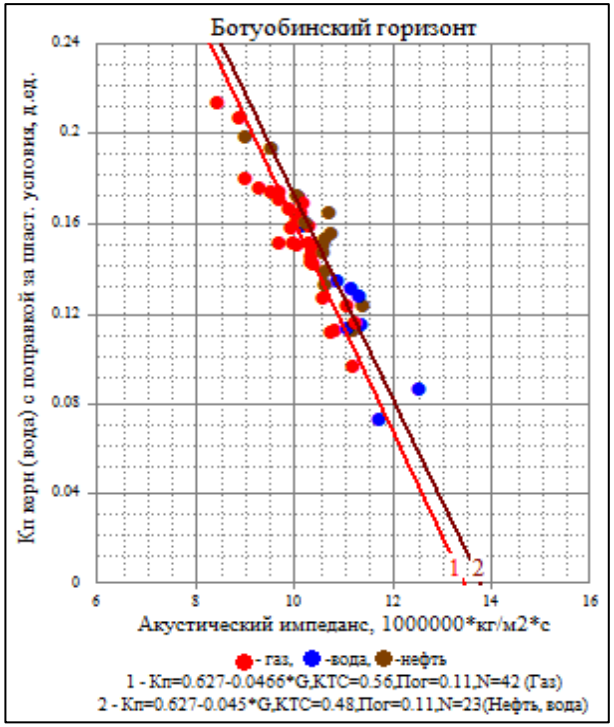


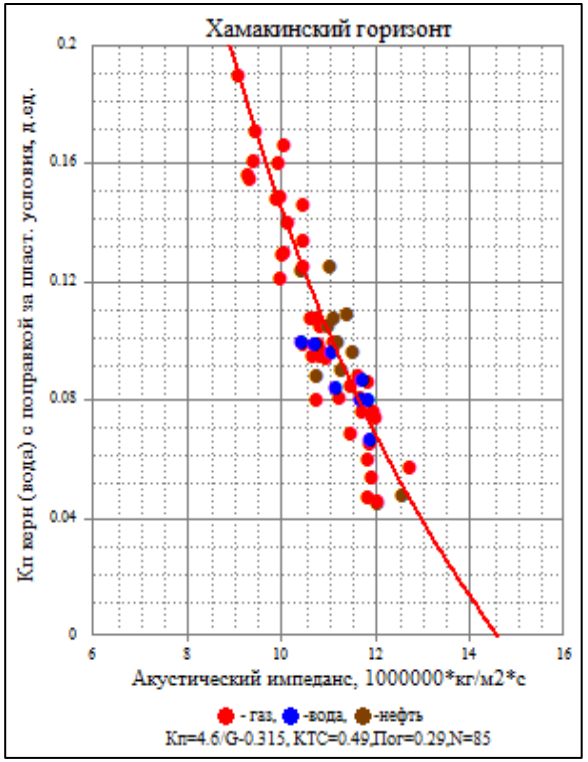
Opening & Dip Angles Correlation scale, relative units

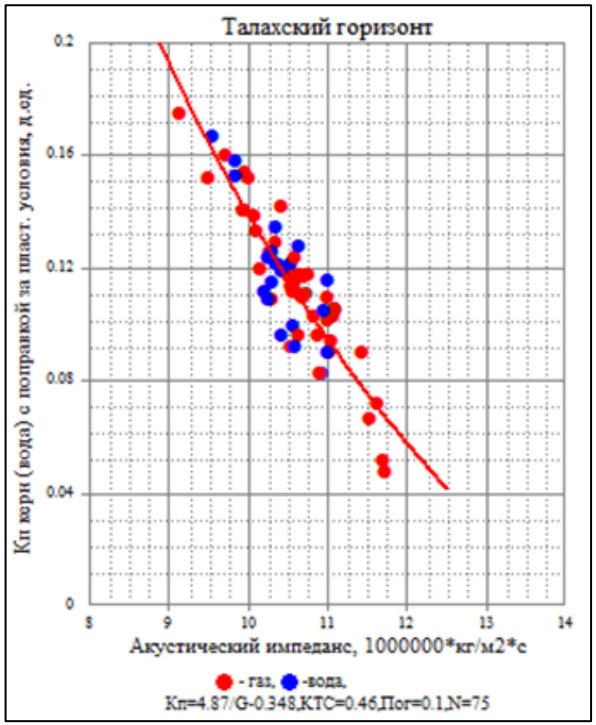
RTH interpretation stages

Stage 5 **Revealing the dependences of petrophysical parameters on RTH-velocity. Creation of forecast maps of improved reservoir properties of productive horizons**

Porosity coefficient versus acoustic impedance based on geological core data (reservoir conditions) and on well logging data

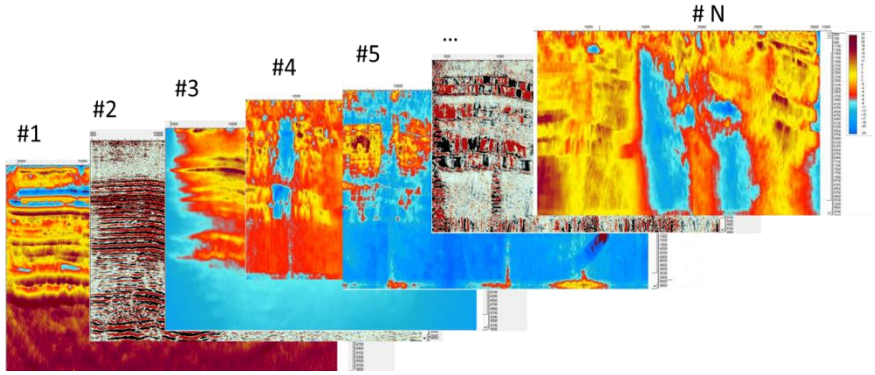




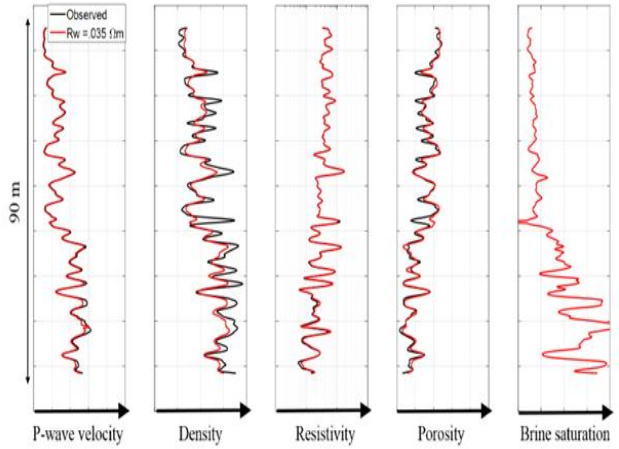


Forecast of hydrocarbon deposits based on RTH attributes and well logging data

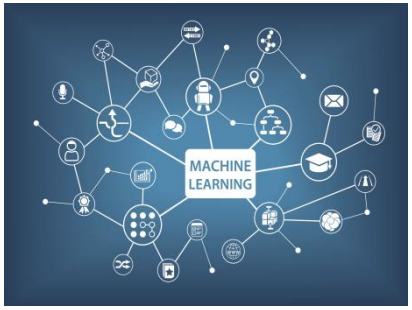
Synchronous calculation of RTH attributes in each voxel of a geological environment up to 1 meter in size

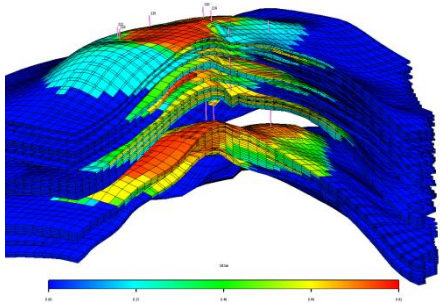


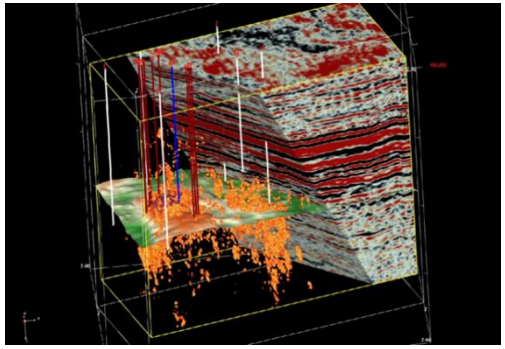
Geophysical well logging data



Machine learning to predict hydrocarbon deposits in the entire geological environment







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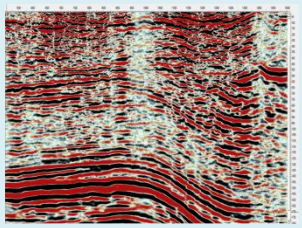
Roadmap for the formation of a direct forecast of the lithological properties of the medium

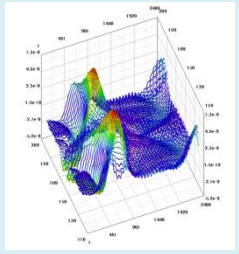
Developed Solutions

Subject to development

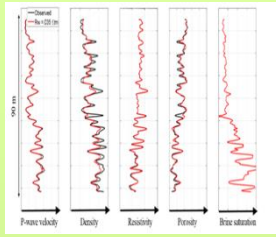
Process



RTH seismic decomposition

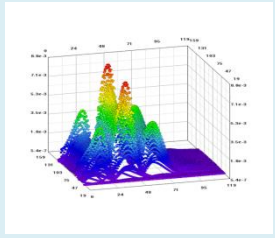


Synthesis step based on analysis of multidimensional statistical distribution of data from VDCIG

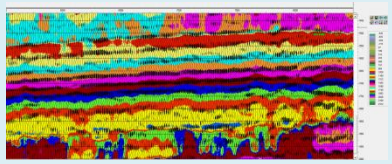


Joint analysis of RTH attributes with well logging data

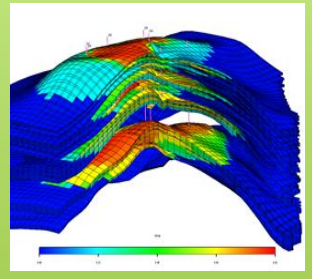
Result



Formation of the data storage the Vector Domain Common Image Gathers – VDCIG



High Resolution RTH Seismic Attributes



Methodology for direct prediction of lithological properties of the medium

Conlusions

The concept of RTH-velocity stratums allows:

1. Mapping discontinuities in the foundation

2. Building structural maps of surfaces and maps of the capacity of productive horizons

3. Building maps of amplitudes of RTH-attributes in the perspective intervals of the geological section

4. Forecasting improved reservoir properties of productive horizons (with presence of a sufficient number of reference wells)

5. Supporting geosteering for drilling horizontal wells

THANKS!