Origin of the Cenozoic Conglomerate Deposits in Kuqa Depression, Tarim Basin, China*

Haitao Sun[1] and Dakang Zhong[1]

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[1]Department of Geology, College of Geosciences, China University of Petroleum at Beijing, Beijing, China (sunhit@msn.com)

Abstract

During Cenozoic, the foreland deformation period of Kuqa Depression in Tarim Basin, western China, there was great alluvial fan deposition with thicknesses up to thousands of meters. However, this alluvial conglomerate became a block to gas exploration in underlying formations. Based on outcrop data, well logs, seismic and 3D electric survey, we analyzed the origin and distribution of the conglomerate in the Cenozoic foreland basin. From outcrop analysis, we confirmed the conglomerate's developmental phase and its size, gradation, sedimentary structure, and composition, by which we classified three deposition types or facies of the conglomerate, and the most dominant was alluvial fan. We measured the thickness and size of several Quaternary alluvial fans in Kuqa Depression by outcrop survey. To study the ancient alluvial fans, we correlated several wells that drilled the Pliocene and Pleistocene alluvial fans, using the well log data, and we analyzed their distributions by the seismic and electric survey. We found the electric data could be a good response to the conglomerate deposition of alluvial fans. The main conglomerate deposition was formed in Kuqa Formation, Xiyu Formation and Quaternary fans. There were three distribution models of the alluvial fan in Kuqa Depression, which were mainly controlled by the tectonic activity during the late Cenozoic and the provenance of different river systems at the northern boundary of the Kuqa Depression. Both of those two factors together controlled the scale and distribution of conglomerate deposition size and the gravel composition. Those alluvial fans were the direct evidence to the foreland deformation of Kuqa Depression, so it could be used to deduce the tectonic deformation history, which has not been confirmed. By analyzing the scale changing processes of alluvial fans, we believed that the foreland tectonic activity started at the Later Kuqa Formation, and the most intense tectonic activity started at the Xiyu Formation, which continued until now.

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Selected Reference

Tang, L., J. Chengzao, P. Xuejun, C. Shuping, W. Ziyu, and X. Huiwen, 2003, Salt-related structures styles of Kuqa foreland fold belt, northern Tarim basin, Science China, v. 33/1, p. 38-46.

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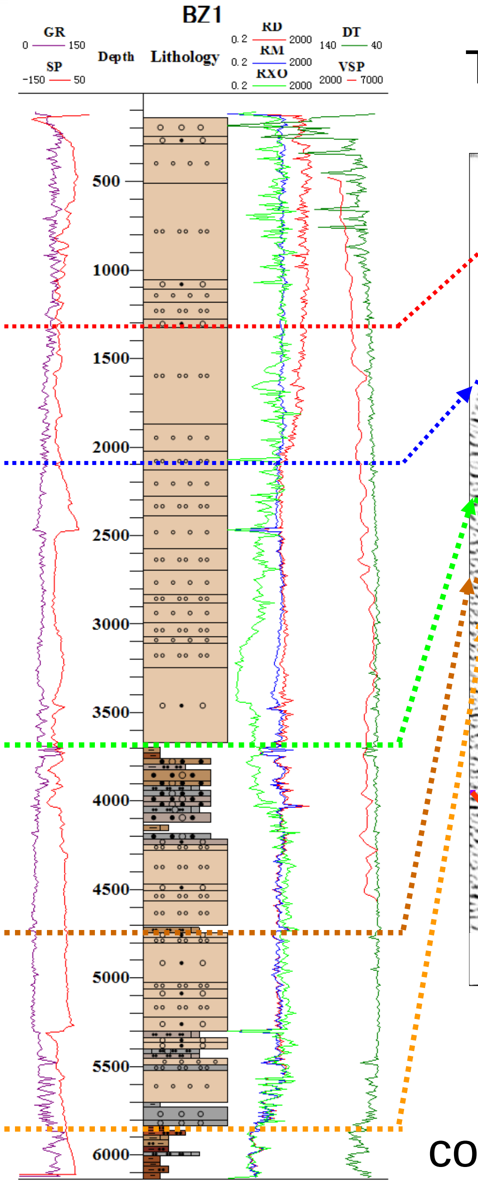
Sun Haitao, Zhong Dakang

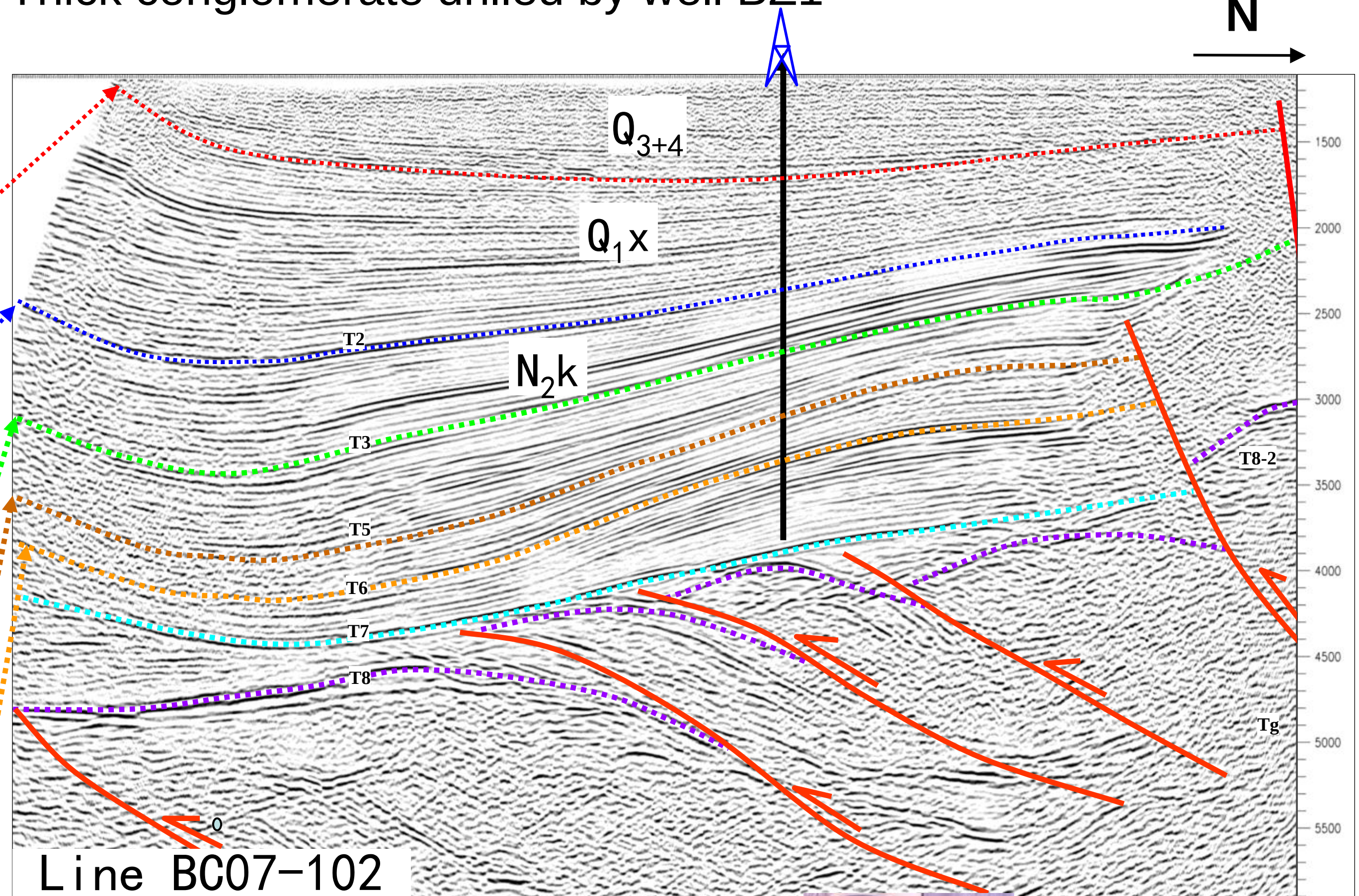
Department of Geology, College of Geosciences
China University of Petroleum at Beijing

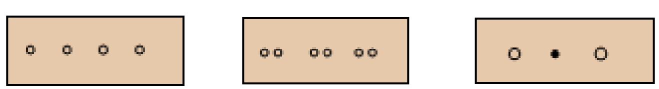
Pittsburgh 2013

Start with a well column & a seismic profile



Thick conglomerate drilled by well BZ1



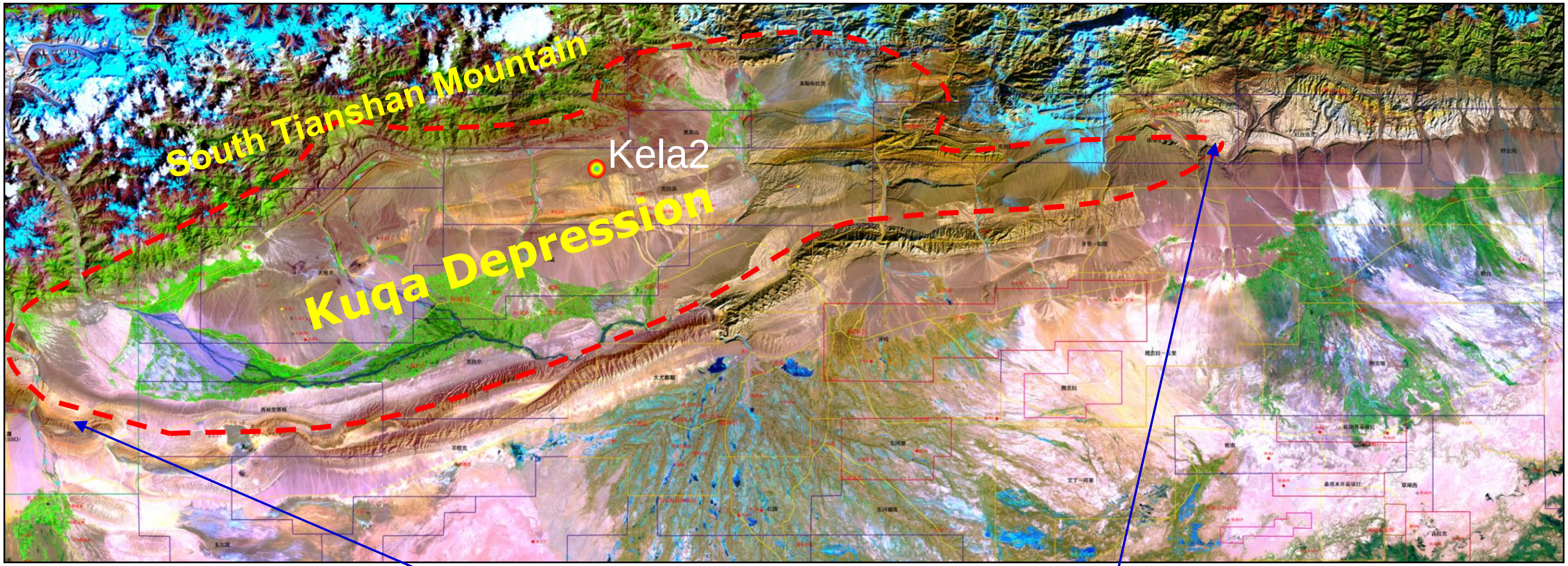


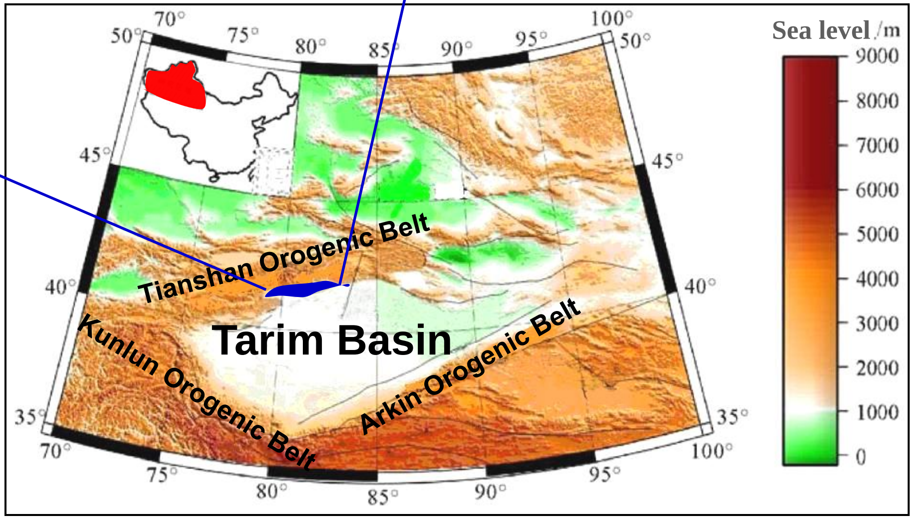
conglomerate with different grain size

Outline

1. Background
2. Routine data analysis
3. Methods Selection
4. Origin and model
5. Summary

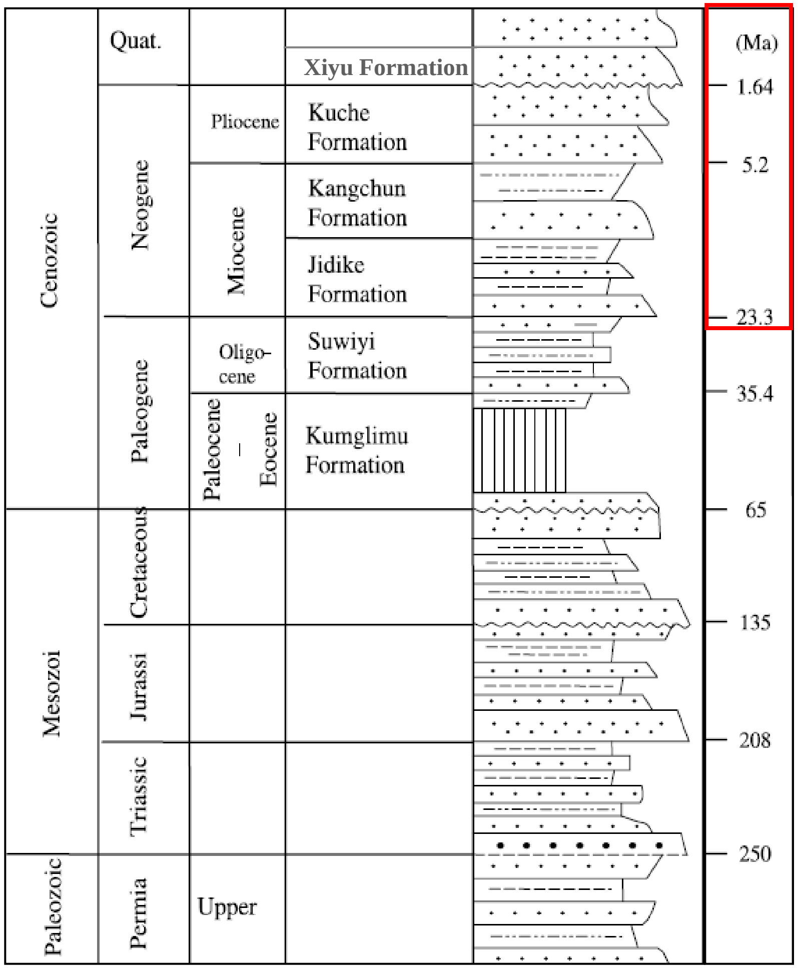
1. Background -Location



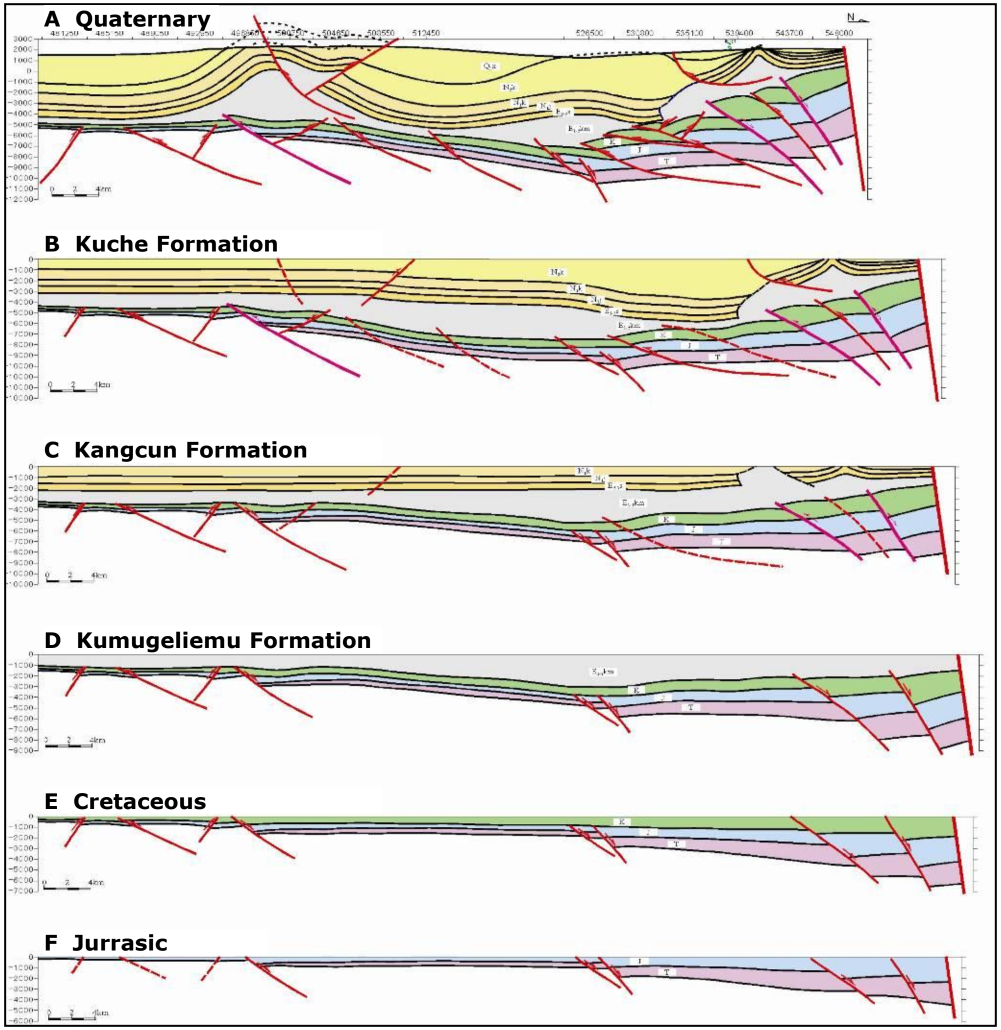


- Tarim Basin
- South Tianshan Mountain
- Foreland Depression
- Cenozoic Alluvial Fans

1. Background -Strata & Structure



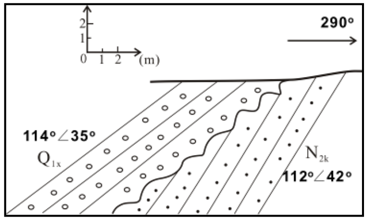
Lithostratigraphic sketches
(Tang LJ,2003)

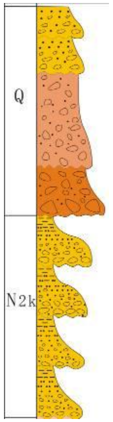


Tectonic Evolution
(Qi JF,2011)

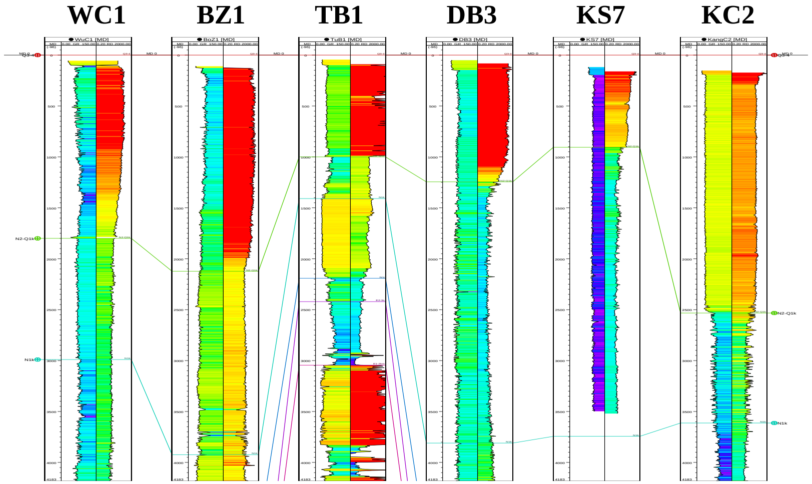
1. Background -G&G Data

➢Outcrop

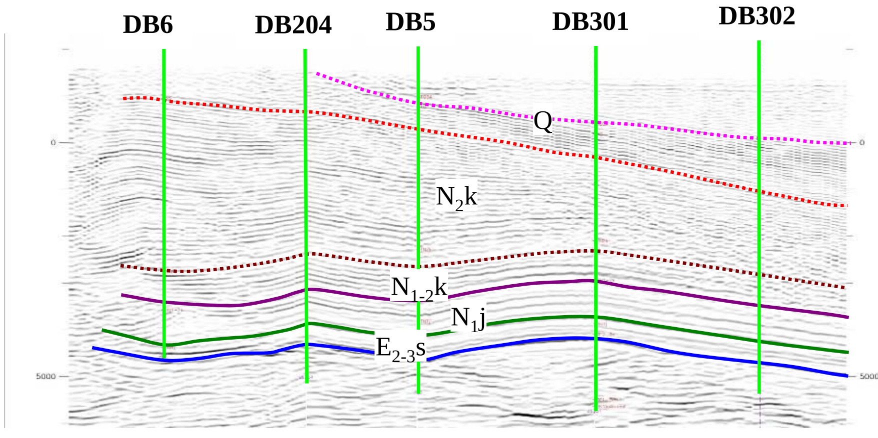




➢A few well columns with GR/SP/DT/RT

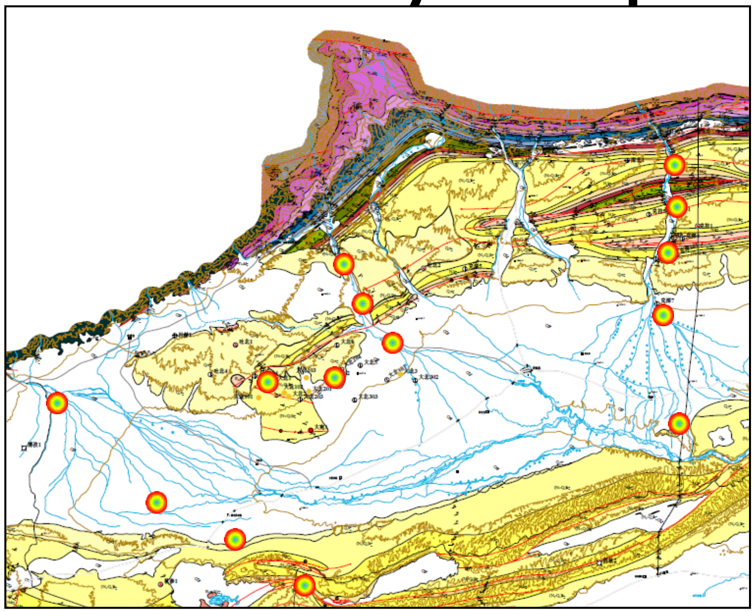


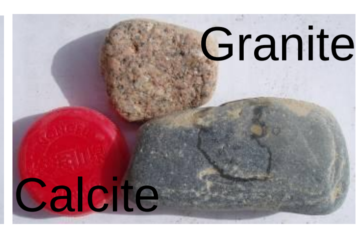
➢2D & 3D Seismic



2. Routine data analysis

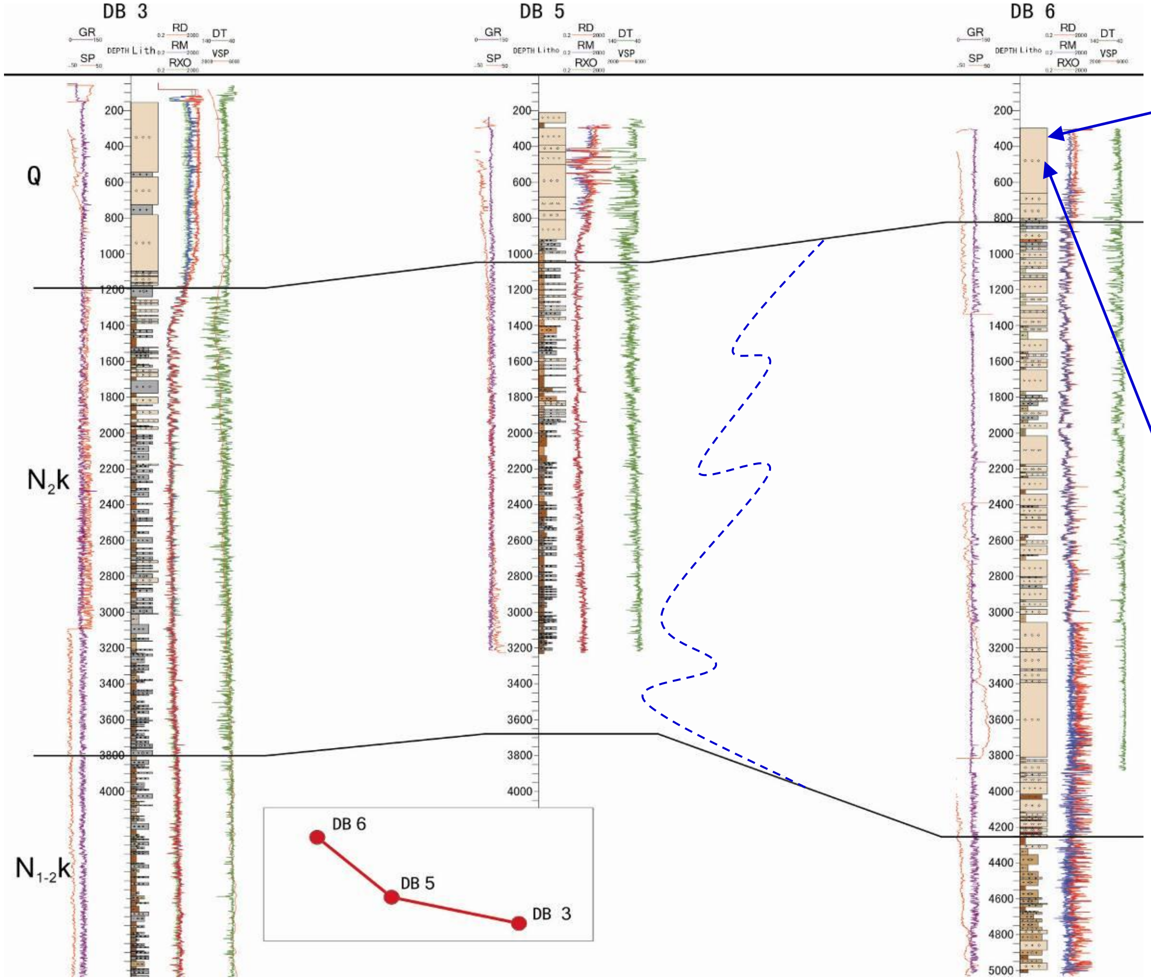
① **analyzing gravel scale, size, component and sedimentary structure by outcrop survey**

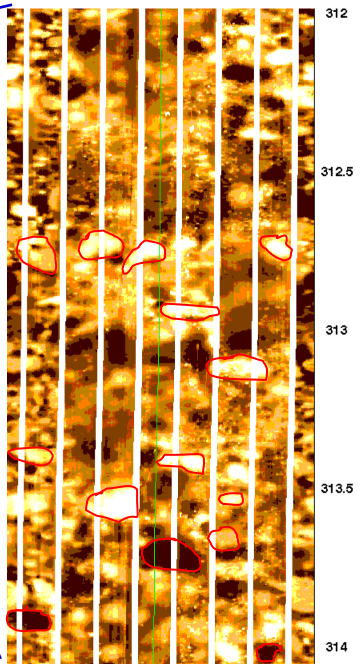




2. Routine data analysis

② **analyzing gravel distribution by well log & seismic survey**

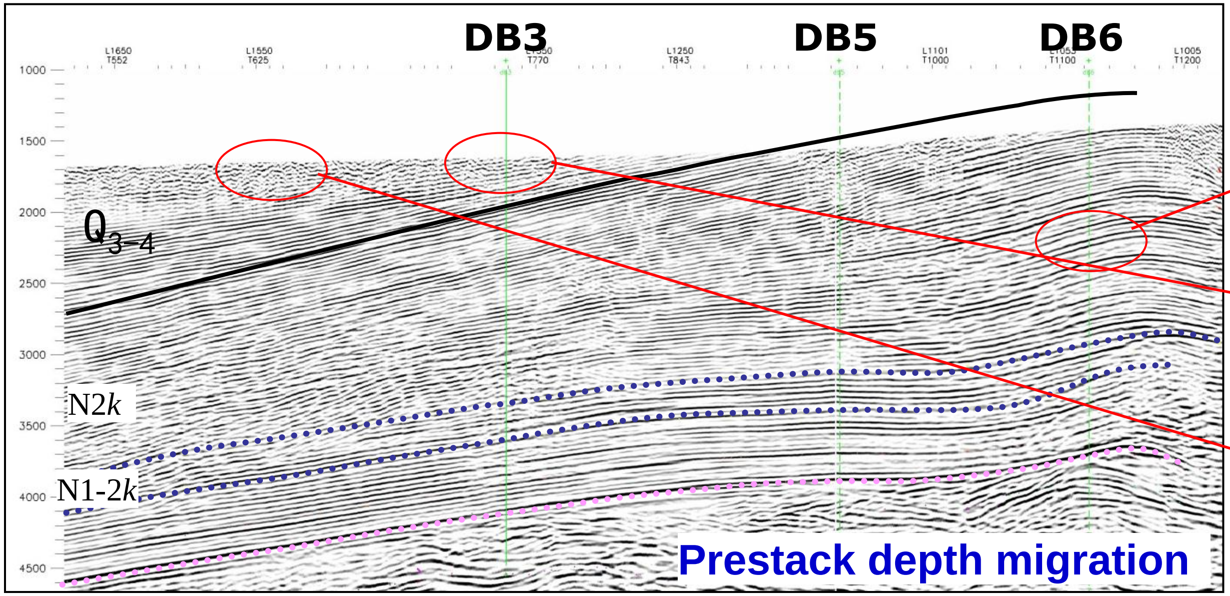


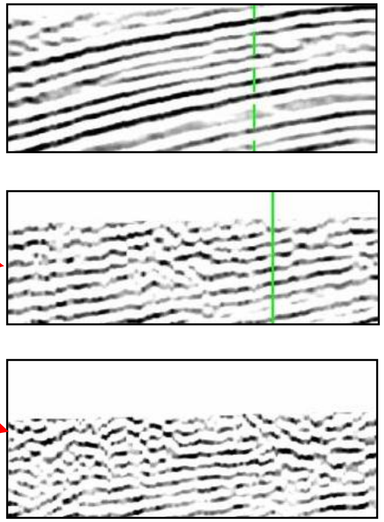


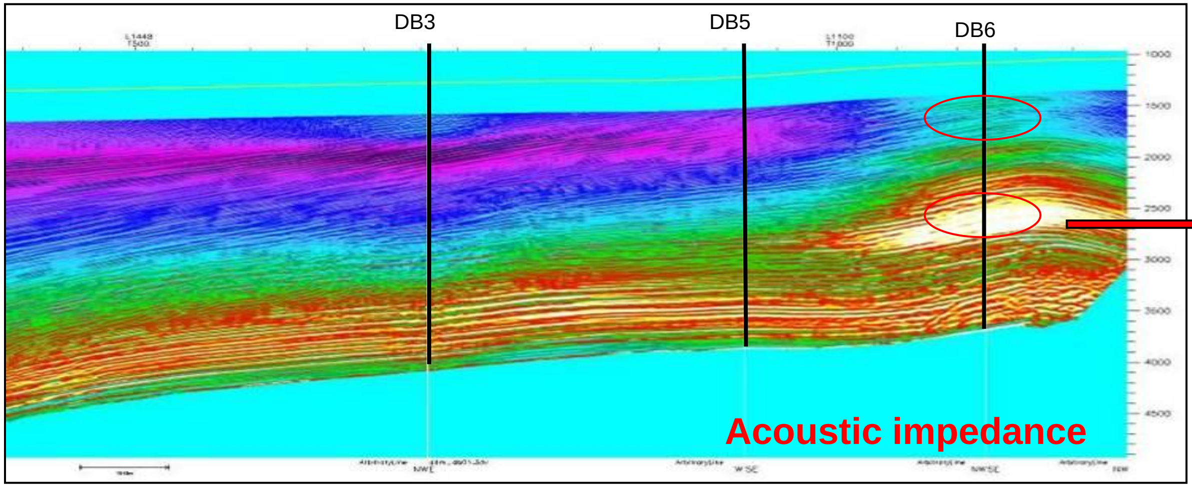
FMI Profile

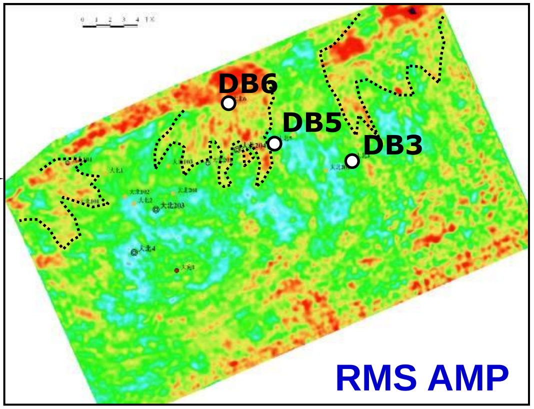
2. Routine data analysis

② analyzing gravel distribution by well log & seismic survey



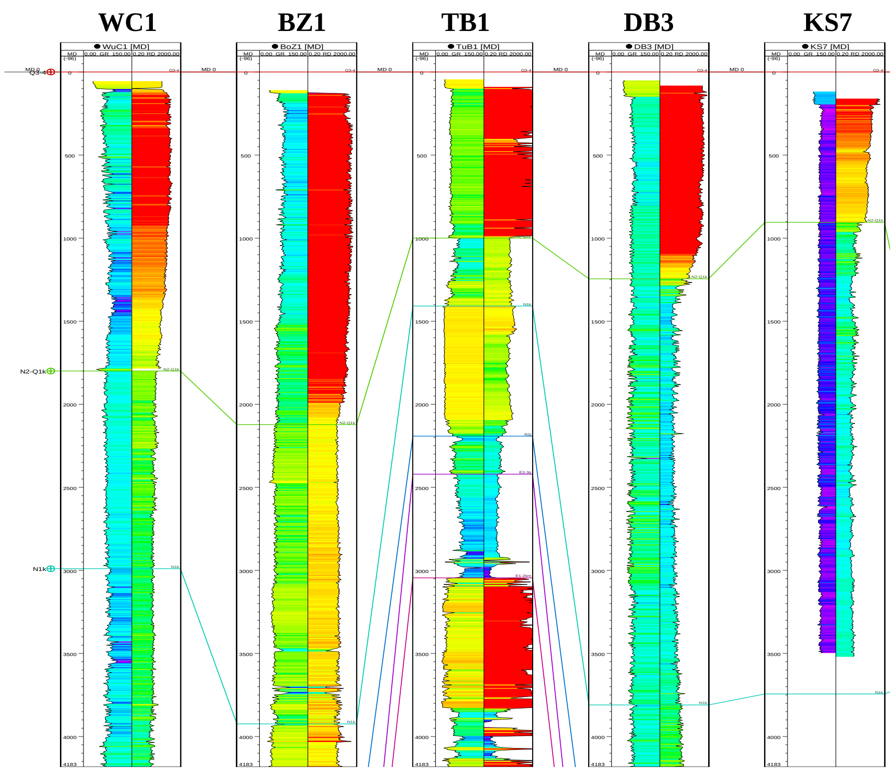






3. Electric survey analysis

- **High Resistivity correspond to conglomerate layers**



- **Electrical resistivities of rocks**

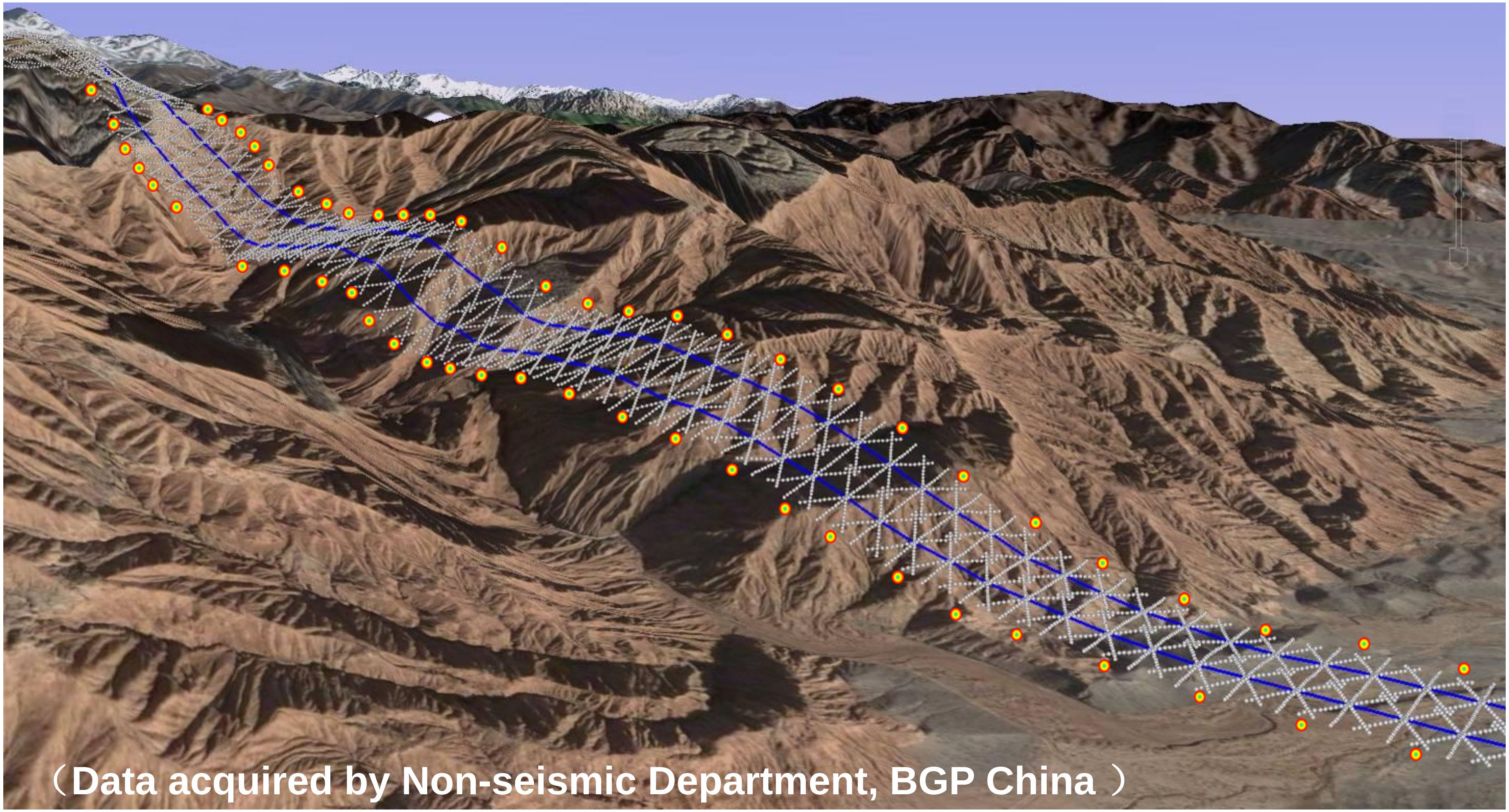
$$V = IR$$

Common rocks	$\rho/\Omega\mathrm{m}$
Topsoil	50–100
Loose sand	500–5000
Gravel	100–600
Clay	1–100
Weathered bedrock	100–1000
Sandstone	200–8000
Limestone	500–10 000
Greenstone	500–200 000
Gabbro	100–500 000
Granite	200–100 000
Basalt	200–100 000
Graphitic schist	10–500
Slates	500–500 000
Quartzite	500–800 000

3. Electric survey analysis

① **Data acquisition & processing**

2D Data acquisition

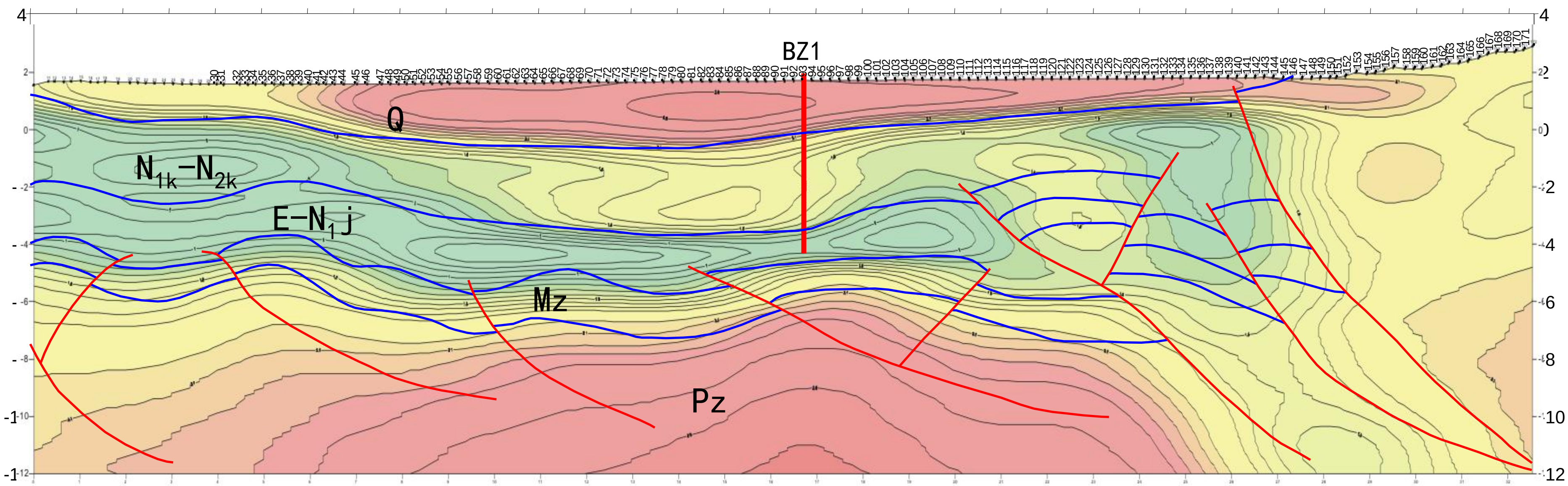


3. Electric survey analysis

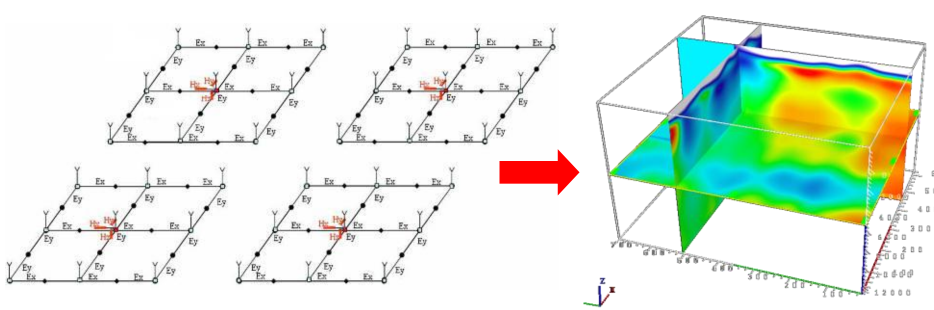
① Data acquisition & processing

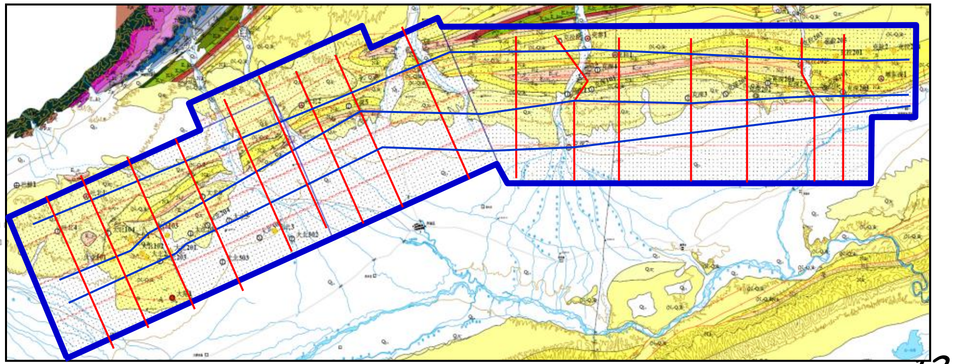
after noise filtering, frequency analysis and inversion

2D apparent resistivity profile BZD04E-105



3D Data acquisition

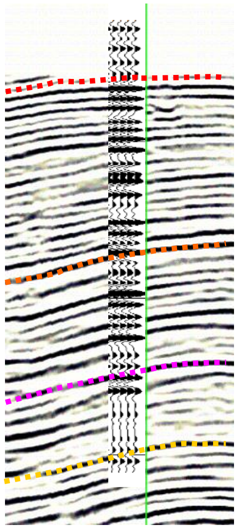




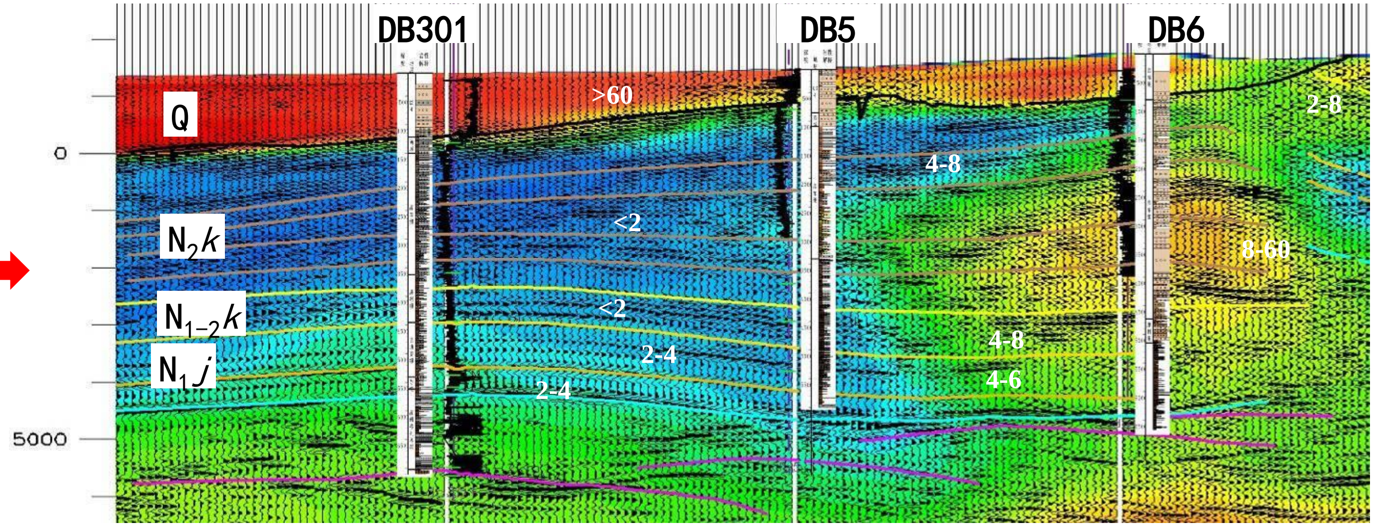
3. Electric survey analysis

② Vertical profile interpretation

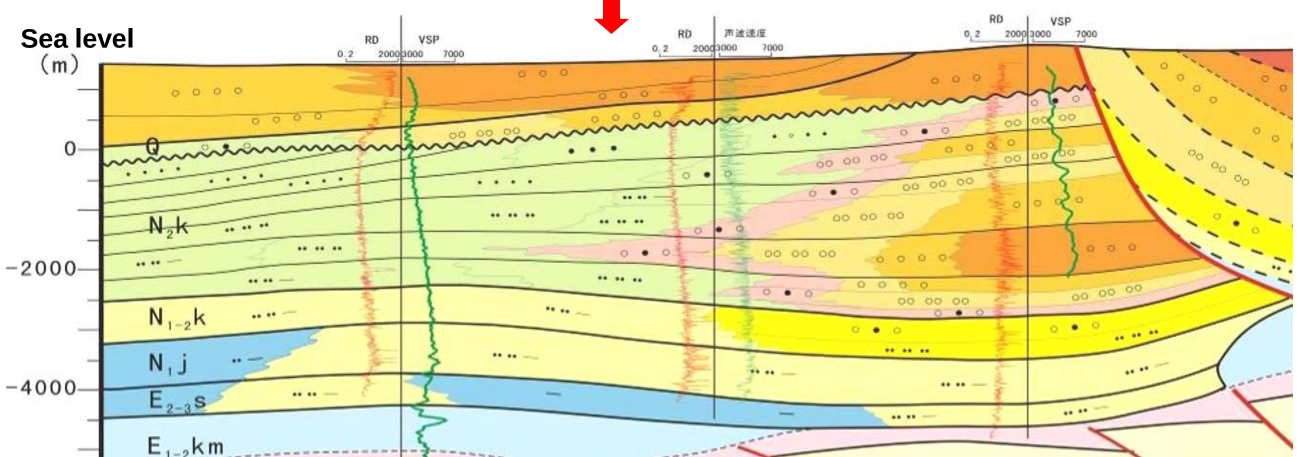
DB6



VSP Calibration



PDM Seismic wiggle overlying 3D electric survey profile

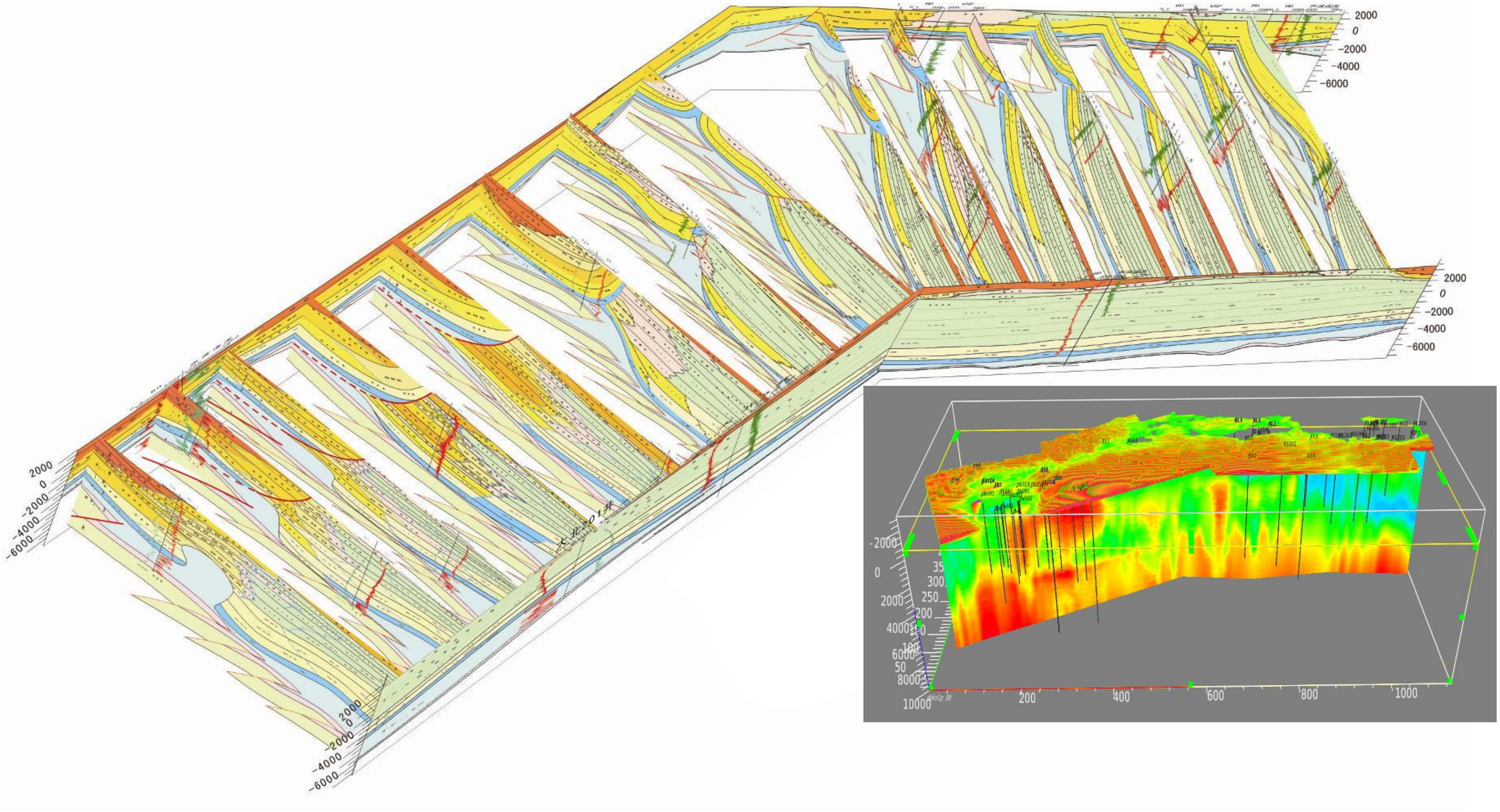


Lithology and lithofacies interpretation profile

3. Electric survey analysis

② Vertical profile interpretation

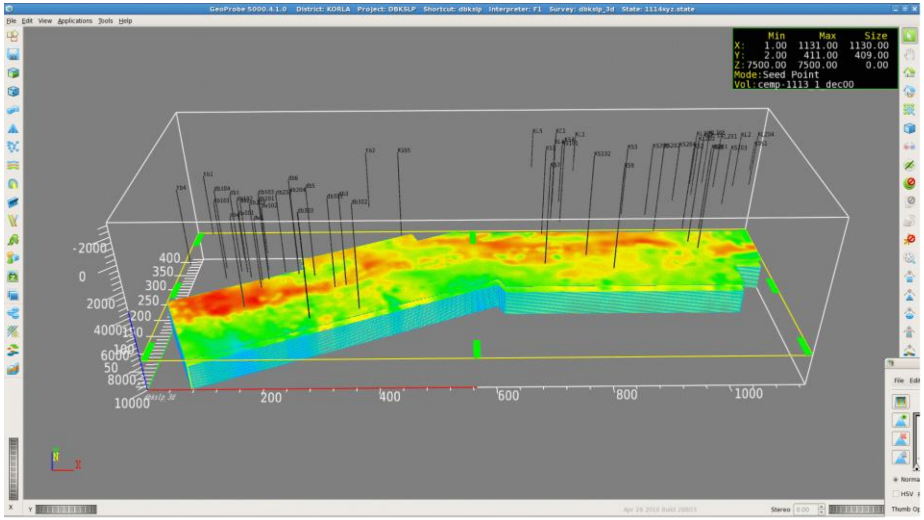
Lithology framework of conglomerate layers in Kuqa Depression

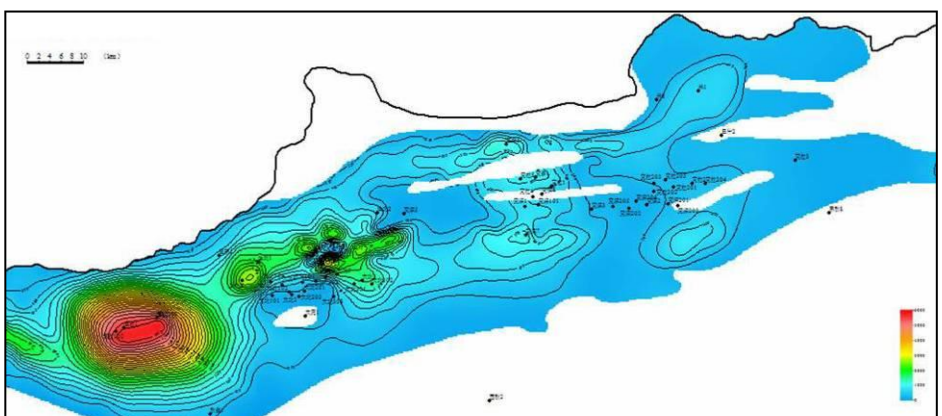


3. Electric survey analysis

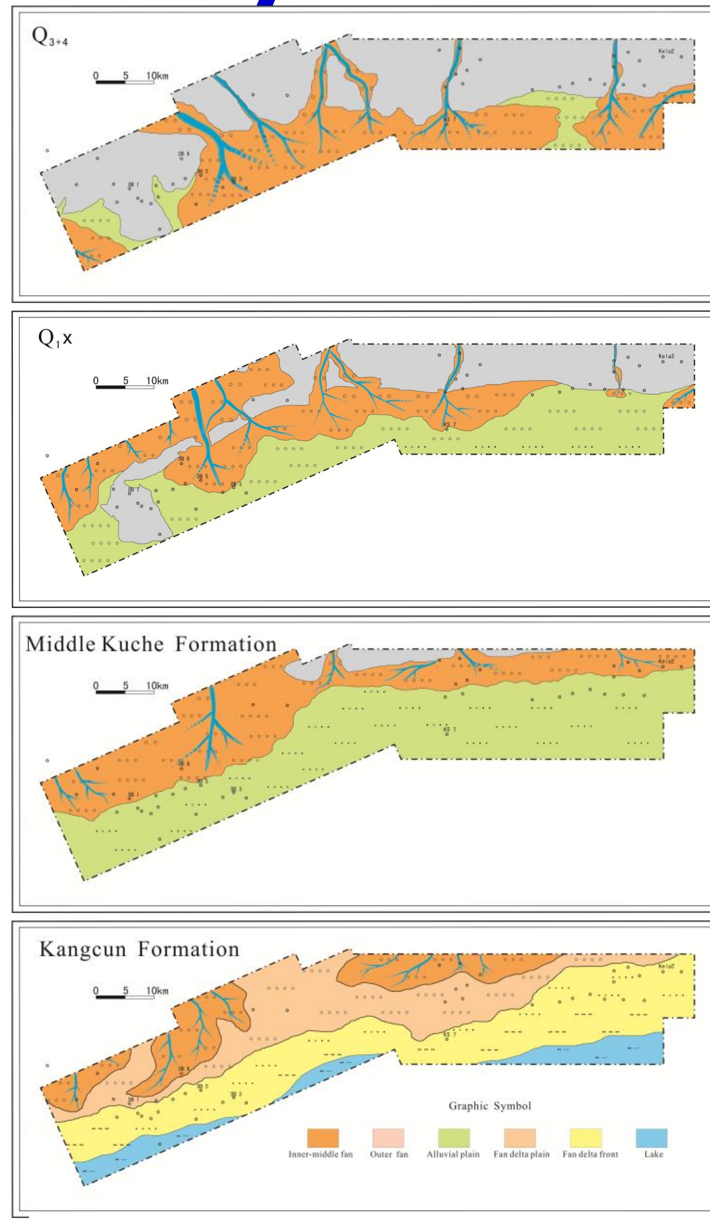
③ Areal distribution

Electric attribution computation





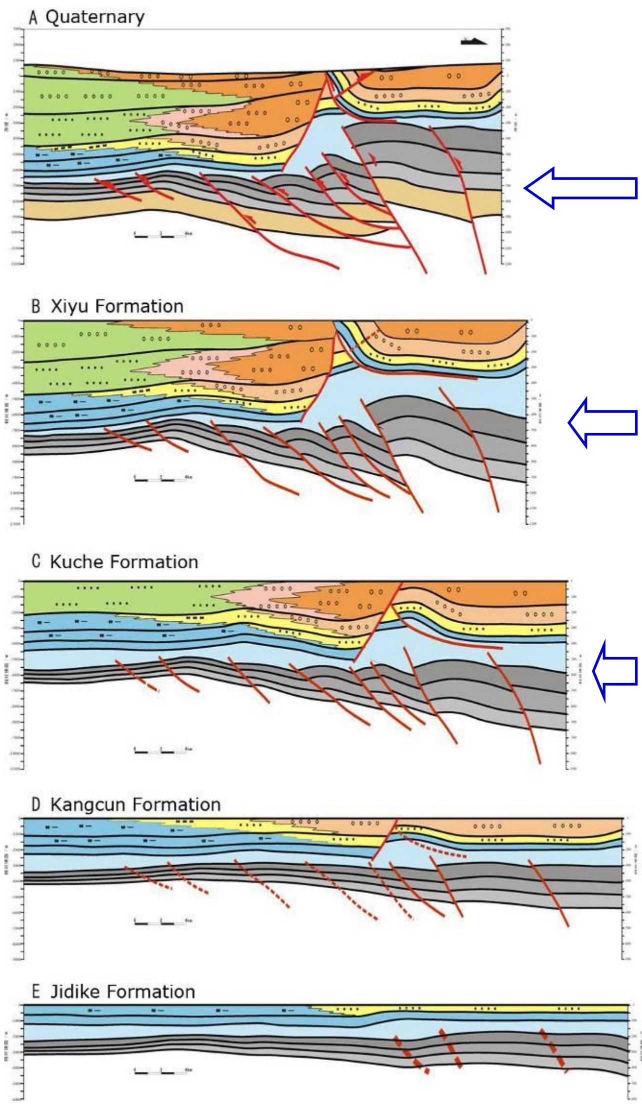
Conglomerate isopach map

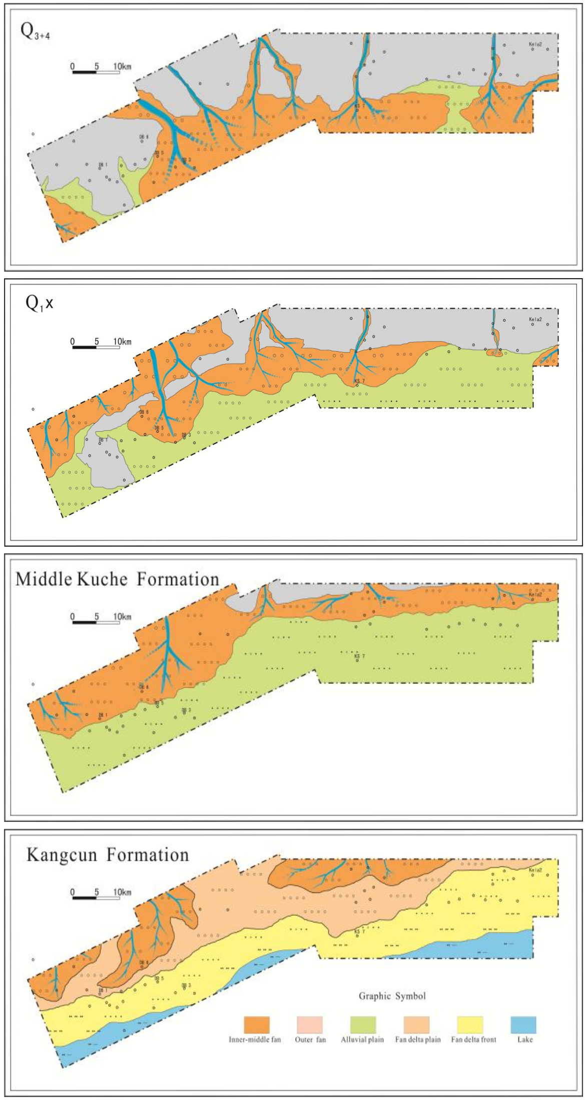


Sedimentary maps

4. Origin & Model

➢**Tectonic** *: alluvial fan was a product of* ***foreland sequence***

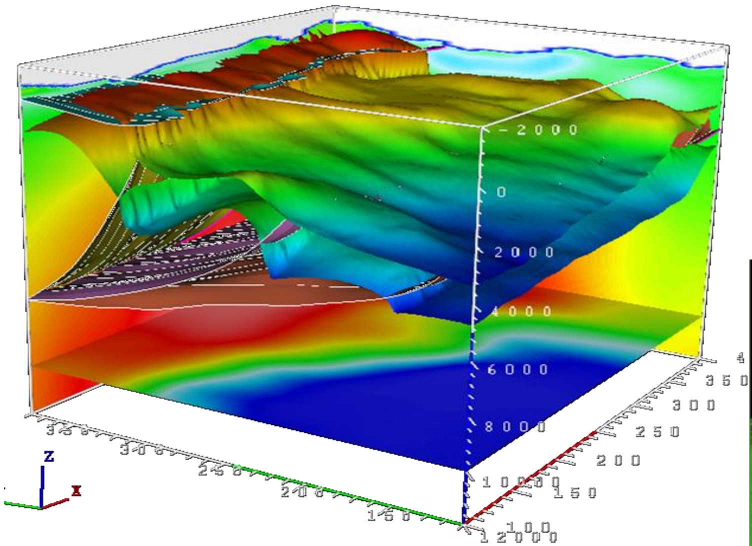




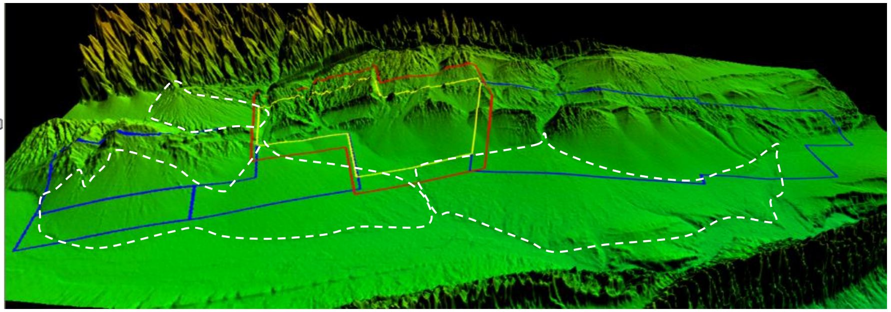
Conglomerate origin from tectonic rise and subsidence during foreland-propagation

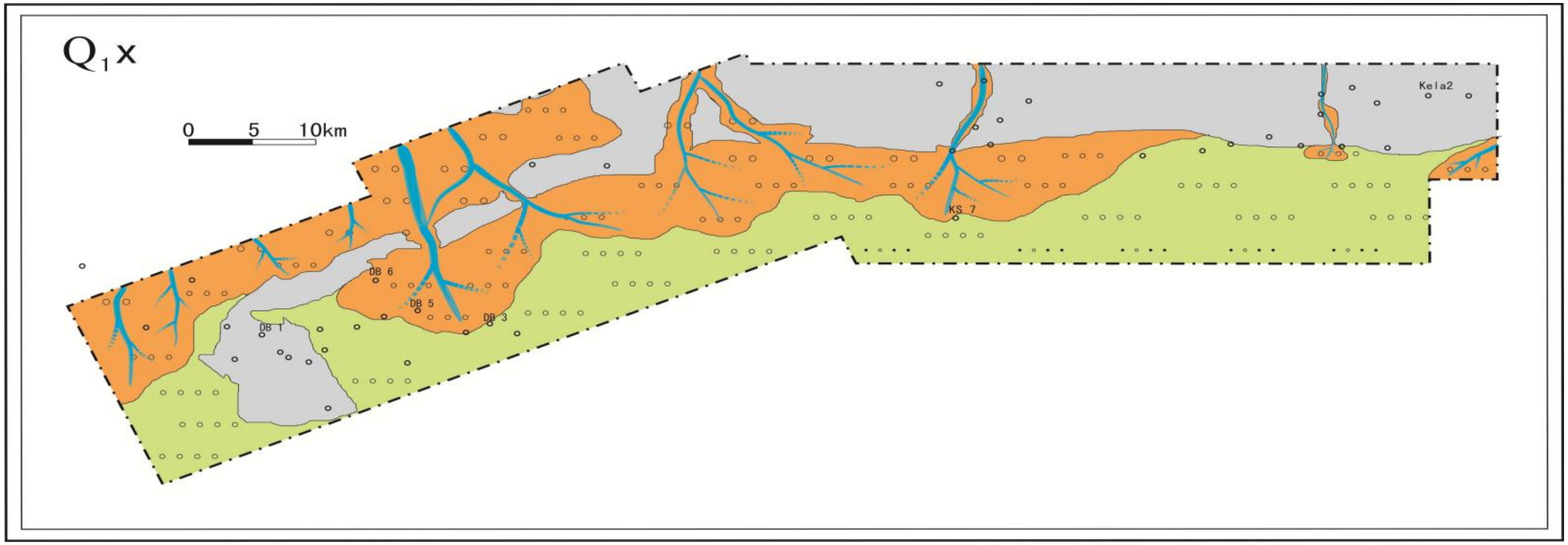
4. Origin & Model

➢**Topography** : *fan's distribution was disturbed by local landform*



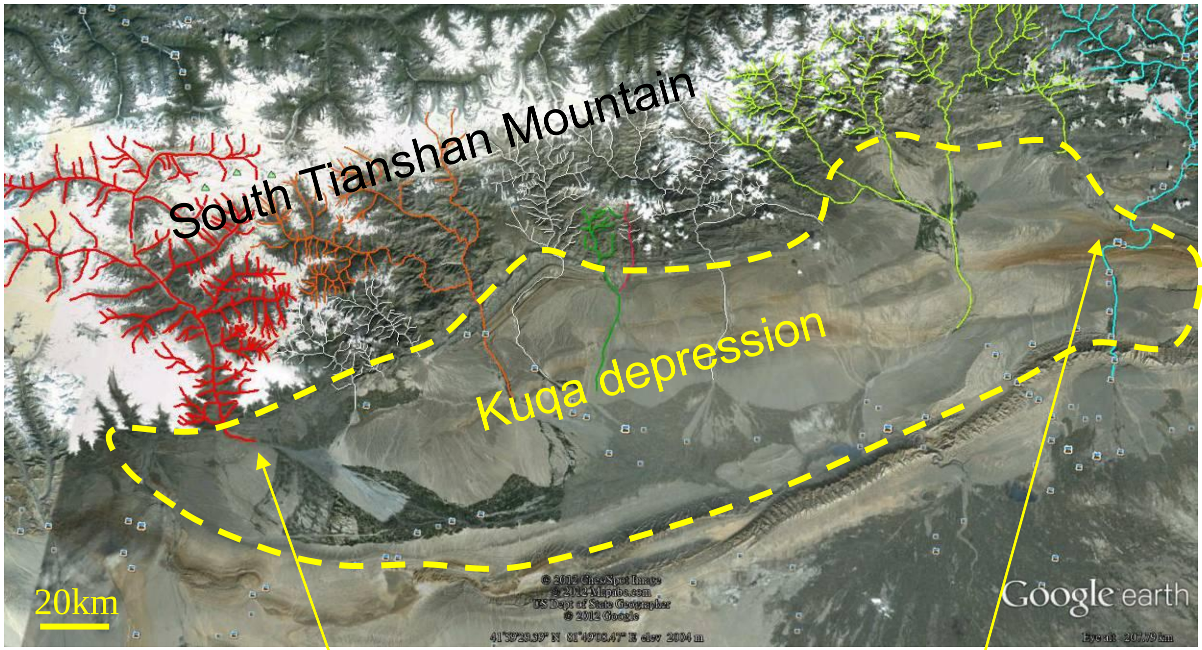
Local structure such as fault and salt diapir **would change fan's normal distribution, including thickness, locations and directions of fan deposits.**





4. Origin & Model

➢**Supply**: *fan scale was controlled by succession water system of arid climate*



✓Large scale alluvial fan was due to seldom large flood deposition of long river--plenty supply from provenance

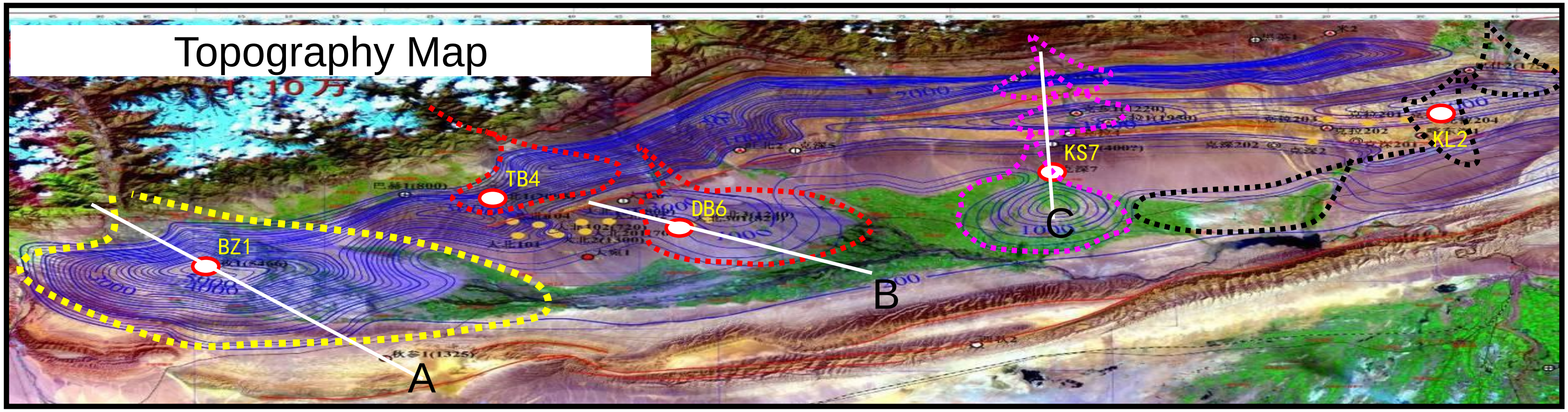
✓Small scale alluvial fan was due to frequent local season flood deposition--small supply

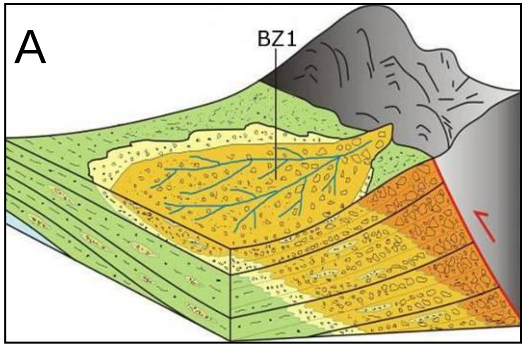

Large alluvial fan

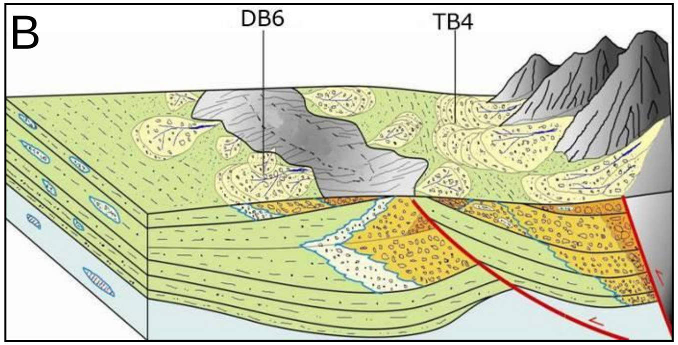

Small alluvial fan

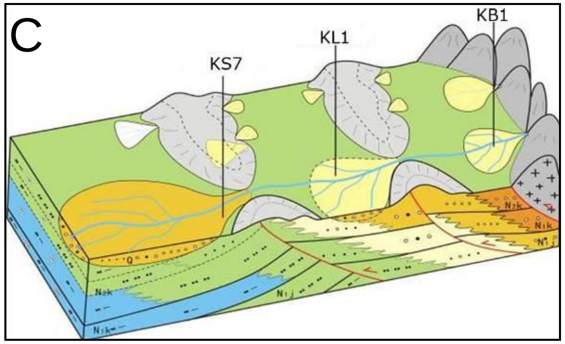
4. Origin & Model

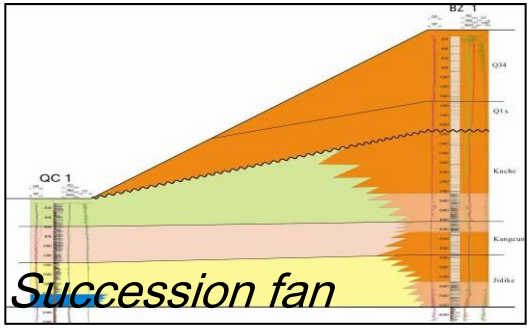
➤**Three tectonic-sedimentary fan models controlled by *TTS***



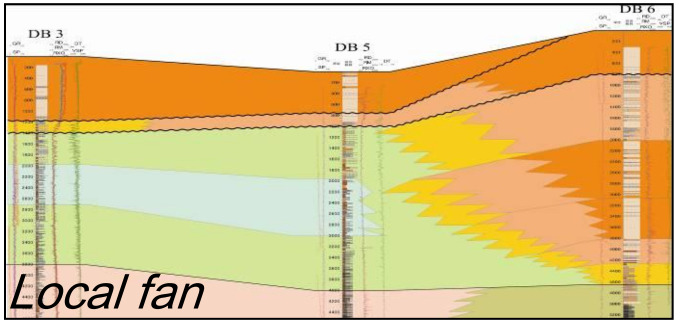




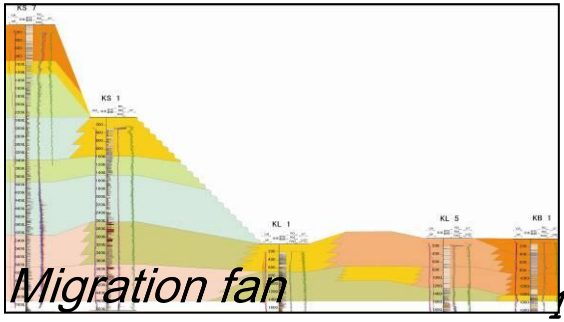




Succession fan



Local fan



Migration fan

5. Summary

①Most conglomerate of Kuqa depression was product of alluvial fan.

②Electric survey was a good method to study conglomerate distribution.

③The formation, distribution and scale of conglomerate were controlled by tectonic, topography and supply of provenance (*TTS*), which formed three tectonic-sedimentary fan models in Kuqa depression.

④Foreland tectonic activity of Kuqa depression started at the Later Kuche Formation, and the most intense tectonic activity enhanced at Xiyu Formation, which continued until now

Acknowledgements To

- *Basic Research Program of China ("973") Grant* ***(NO.2011CB201104)***
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- *China University of Petroleum-Beijing Travel Grant*
- *AAPG 2013 ACE Organizing Committee*