



GLACIER STRESS PATTERN AS AN INDICATOR FOR CLIMATE CHANGE

Presented by

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CLIMATE CHANGE

- Climate change:
 - Global phenomenon
 - changes in temperature
 - changes in amount of moisture
 - **Glaciers sensitive to temperature fluctuations**
 - Retreat of the glaciers
 - Thinning of the glaciers



POLAR REGIONS

- Pristine area for the study of **climate change**.
- it can cause glaciers to melt
- but the relationship is not straightforward,
 - eg. **Antarctica**: climate change-->warmer-->more evaporation from ocean ->more water vapor -> more snowfall!
 - and in Arctic Region: climate change→imbalance of ice



INTERNAL DEFORMATION OF ICE MASS

- By gravity, surface slope & ice thickness (plastic deformation produced by its weight)
- A glacier flows – In response to stress within the ice mass by the force of gravity.

Two components.

Hydrostatic pressure

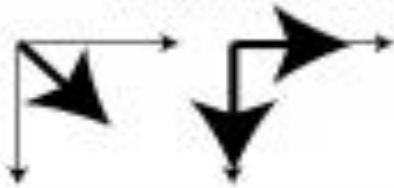
- Same in all directions at any point
- Related to weight of the overlying ice.

Shear stresses

- Cause particles to slip past one another and related to
 - 1- Weight of overlying ice mass / ice thickness.
 - 2- Surface slope of the glacier.
 - 3- Bedrock slope of the glacier.



GLACIER STRESS AND STRAIN



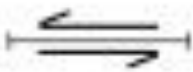
FORCE
A PUSH OR A PULL



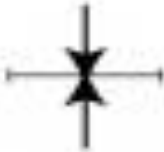
TRACTION
FORCE PER UNIT AREA ON A SURFACE OF A SPECIFIED ORIENTATION



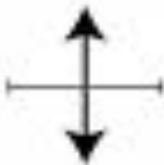
SURFACE STRESS
A PAIR OF EQUAL AND OPPOSITE TRACTIONS ACTING ACROSS A SURFACE AT A PARTICULAR ORIENTATION



SHEAR STRESS
A PAIR OF TRACTIONS ACTING PARALLEL TO A SURFACE

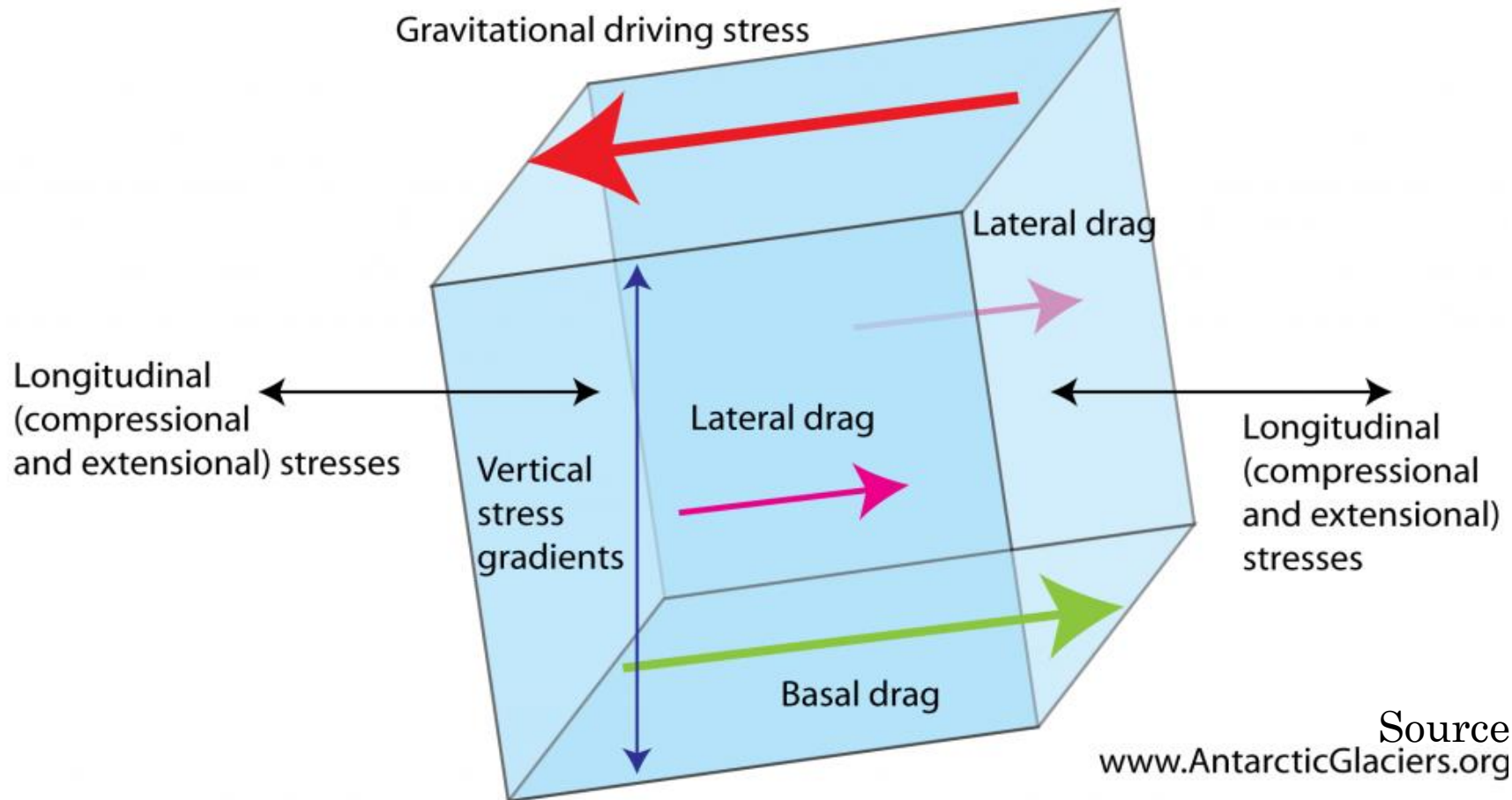


NORMAL STRESS – COMPRESSIVE
A PAIR OF TRACTIONS ACTING AT RIGHT ANGLES



NORMAL STRESS – TENSILE
A PAIR OF TRACTIONS ACTING AT RIGHT ANGLES

GLACIER STRESS AND STRAIN

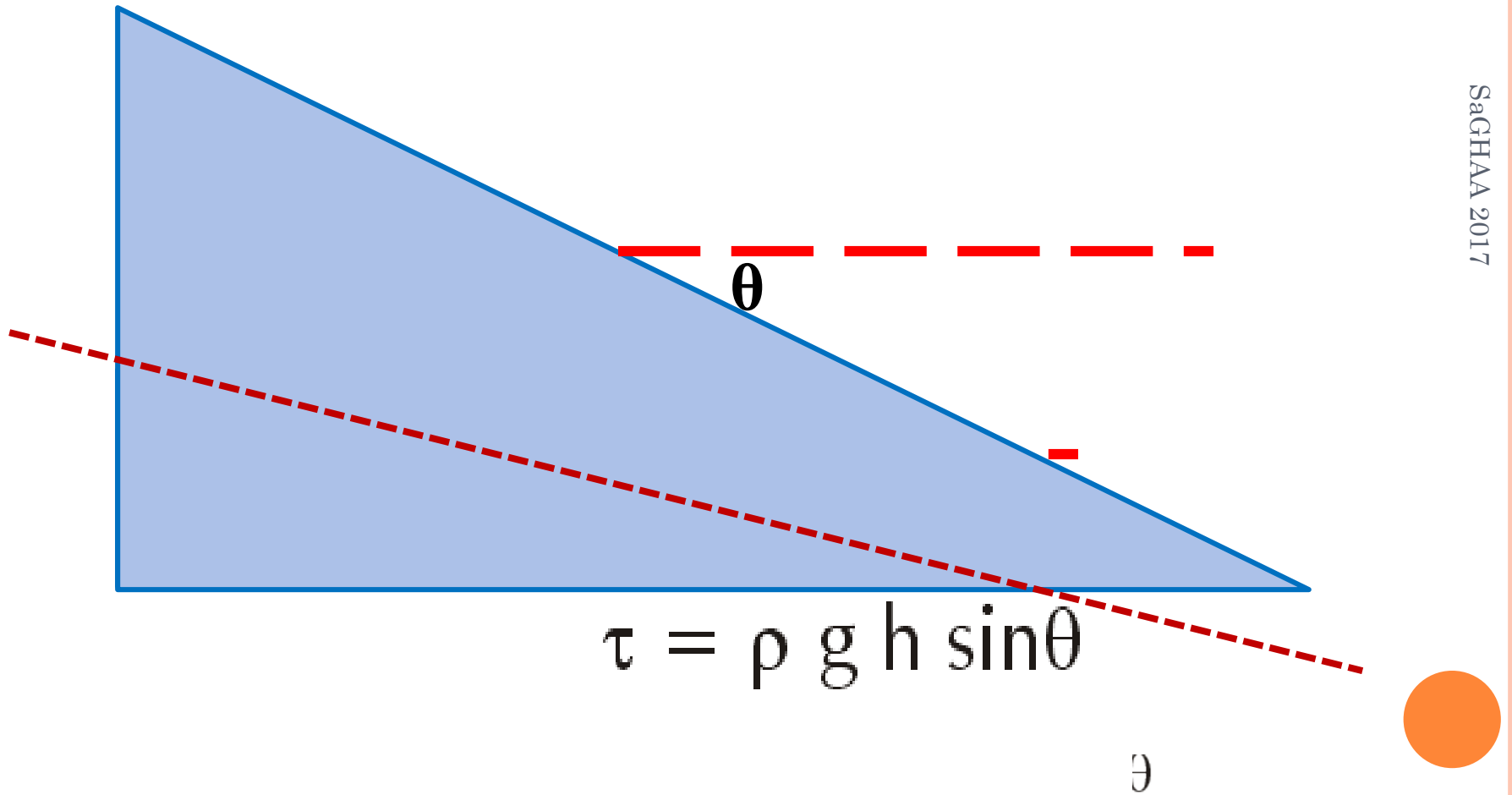


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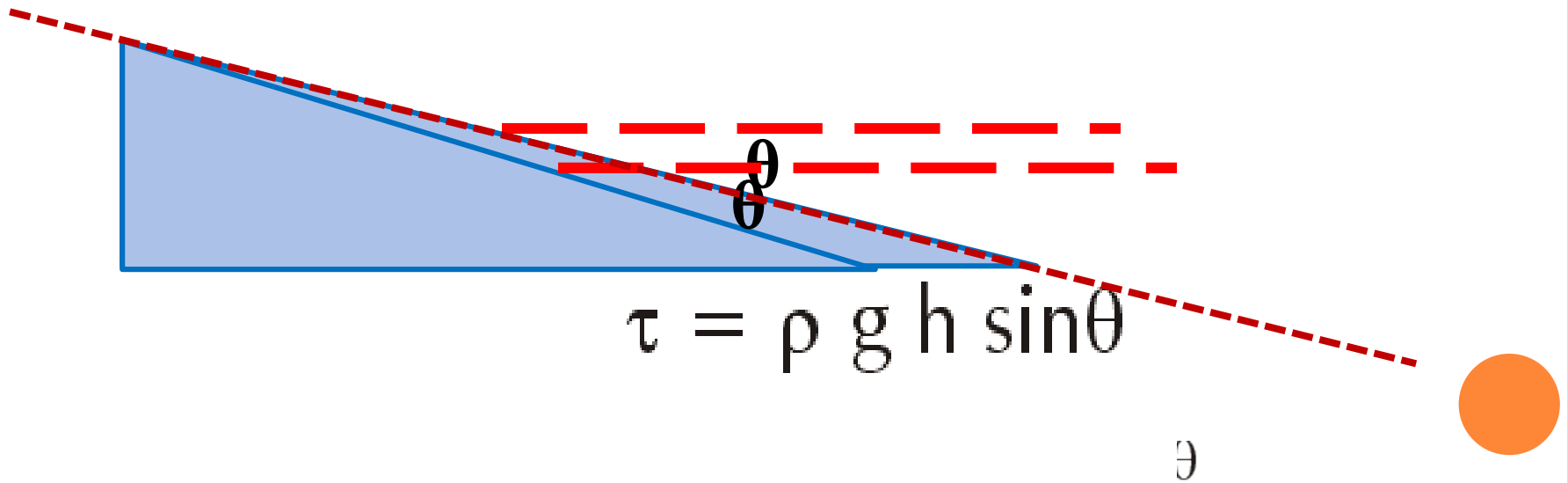
Source
www.AntarcticGlaciers.org



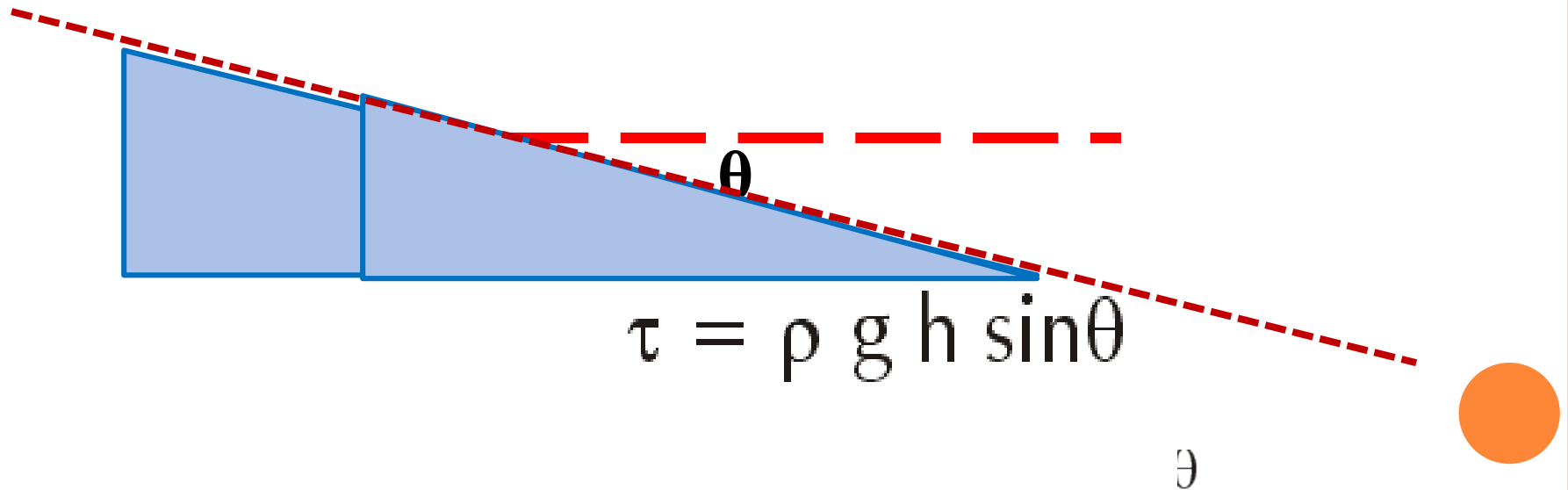
MODEL 1: TOWARDS A COOLING PHASE

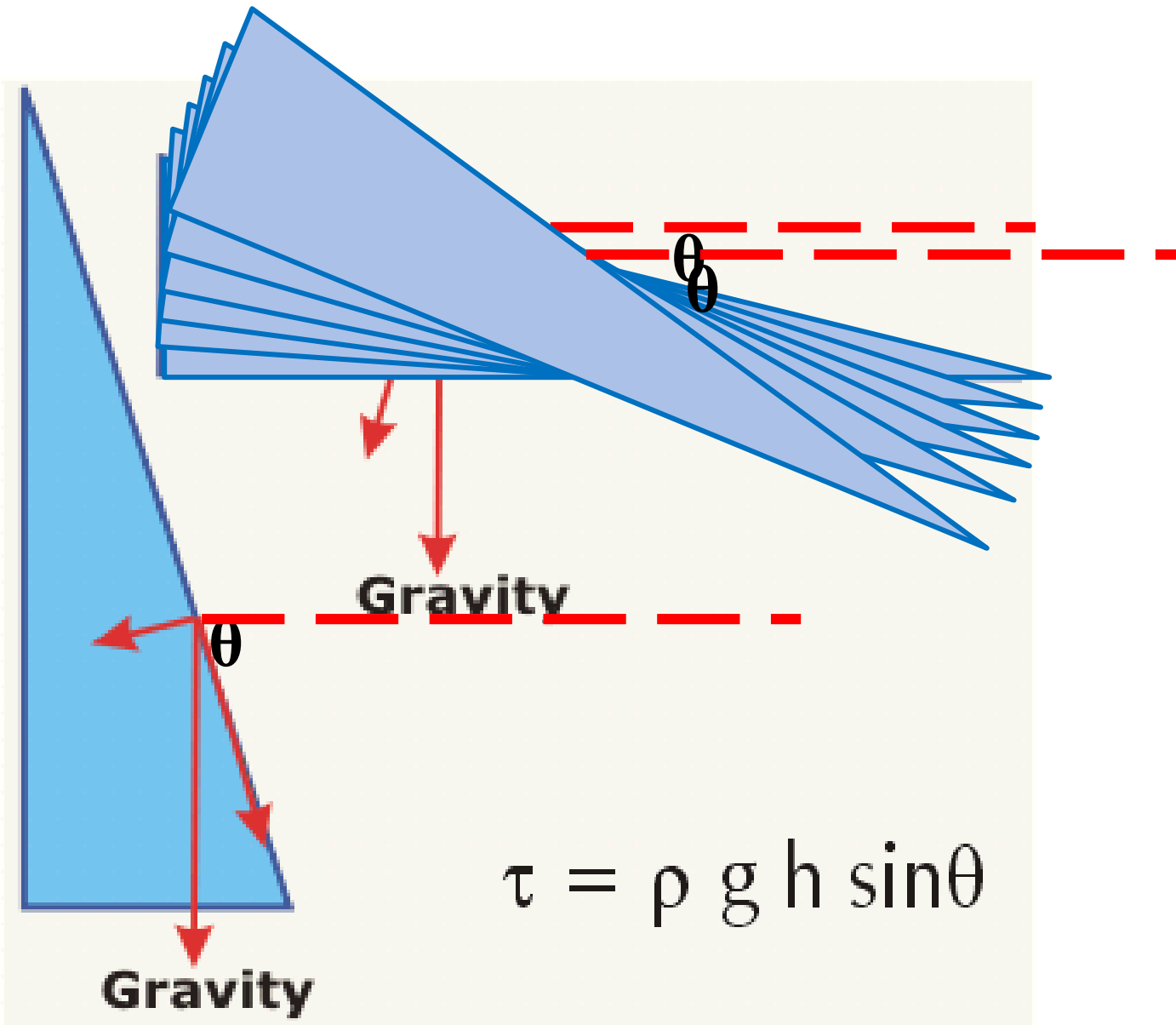


MODEL 2: TOWARDS A WARMING PHASE



MODEL 3: IN A NO-CHANGE SCENARIO

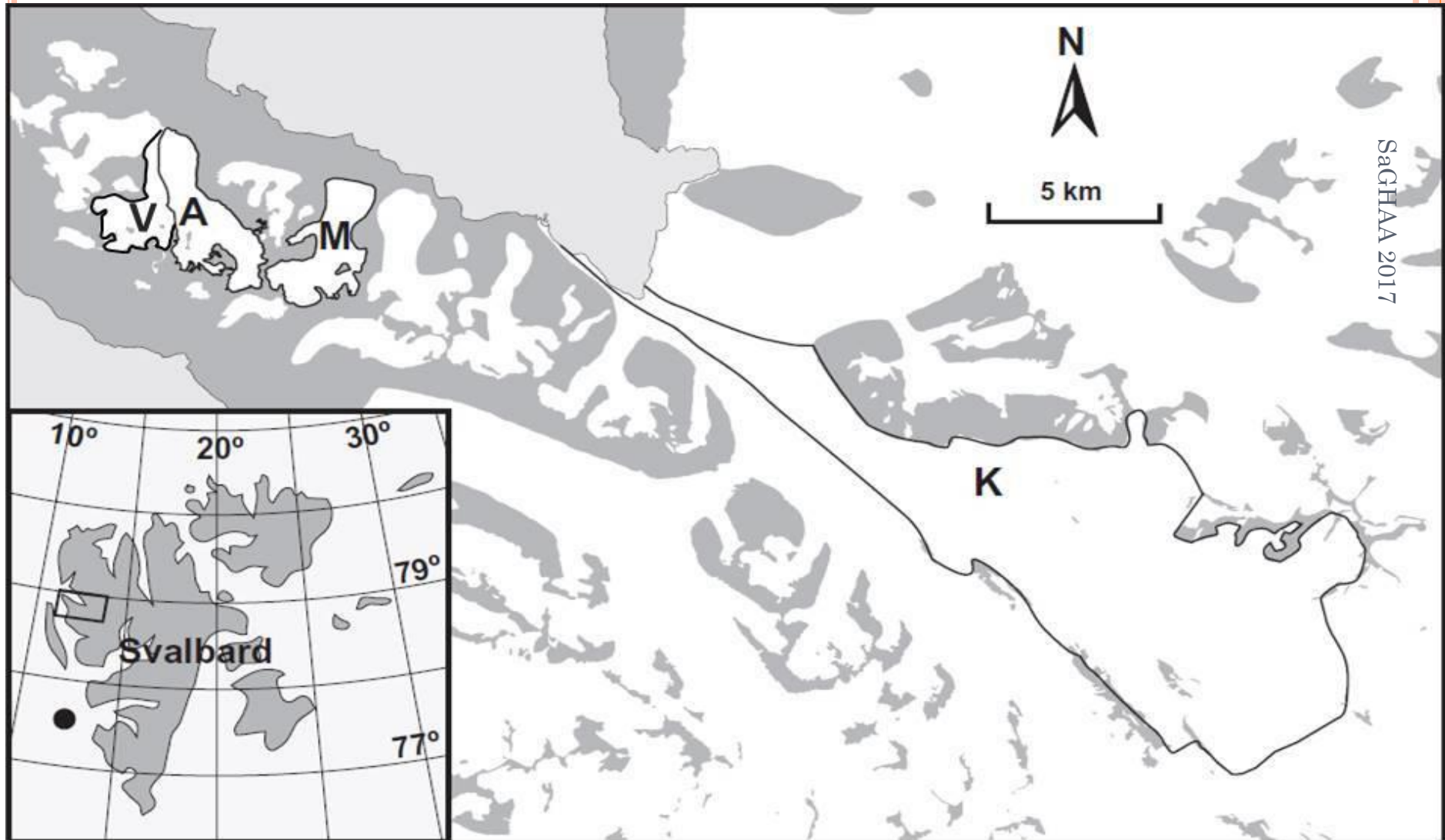




$$\tau = \rho g h \sin \theta$$



NY-ÅLESUND GLACIER IN SVALBARD ARCTIC



VESTRE BROGGERBREEN GLACIER / NY-ALESUND CLIMATE

(Area = 4.69 Km).

VB-I is 4.5 km long and width is 0.85km.

VB-II is 2.3 km long and width 1.1 km.

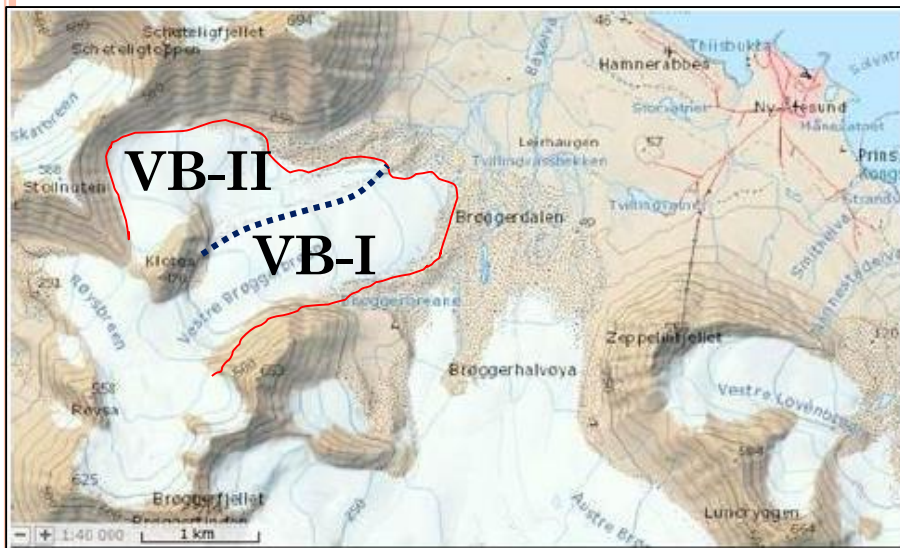
Average mean annual temp. = -5.8° C.

Warmest summer temp. = 21.3° C.

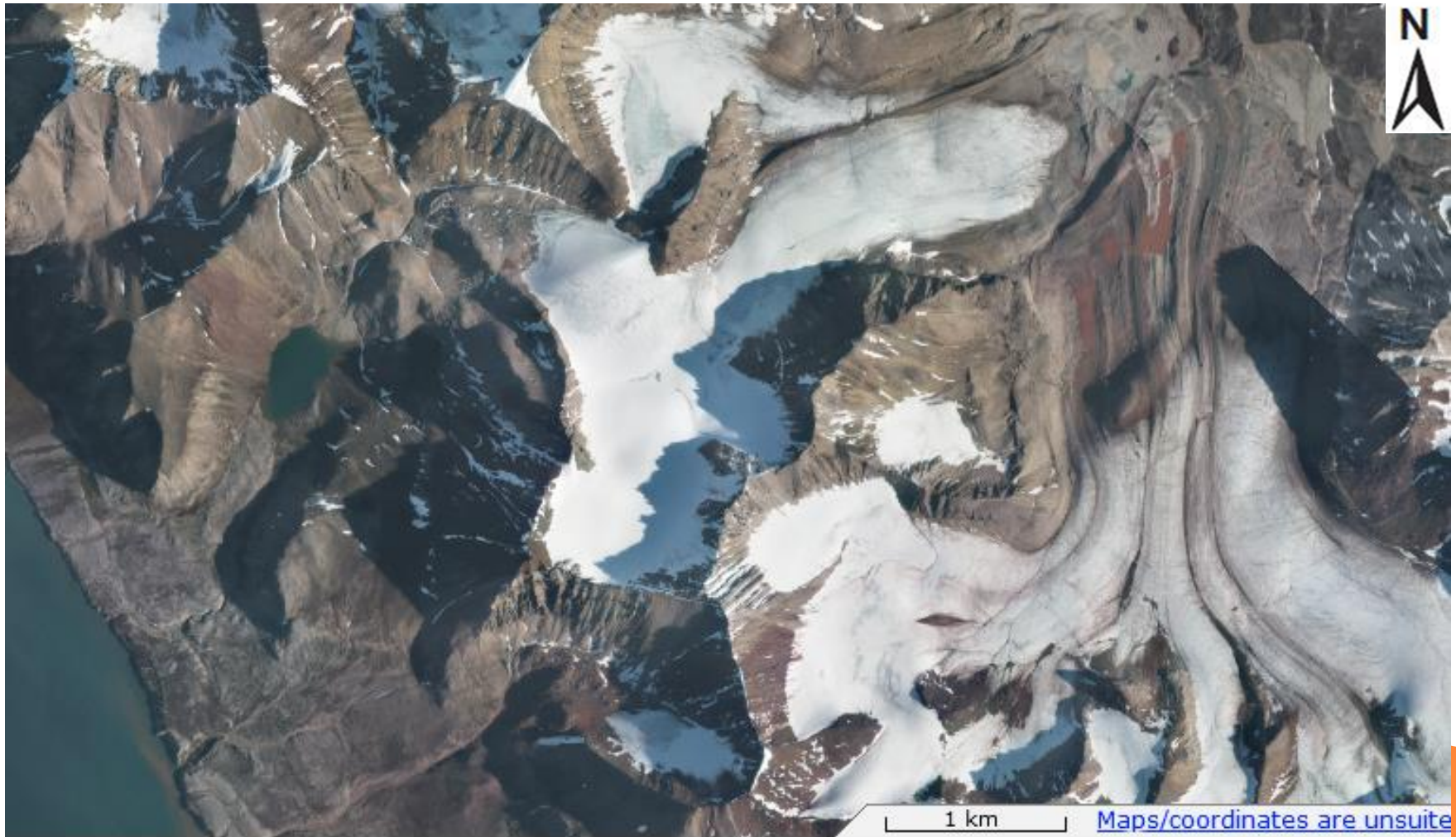
Average winter temp. = -15° C.

Coldest recorded temp. = -46.3° C.

Annual Pptn (Rain+snow) = ~ 30 cm.



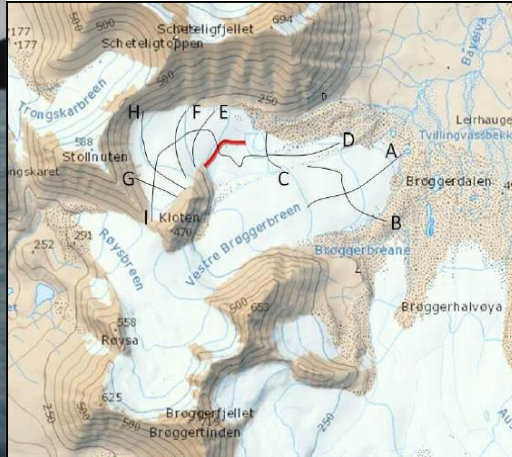
VESTRE BROGGERBREEN GLACIER



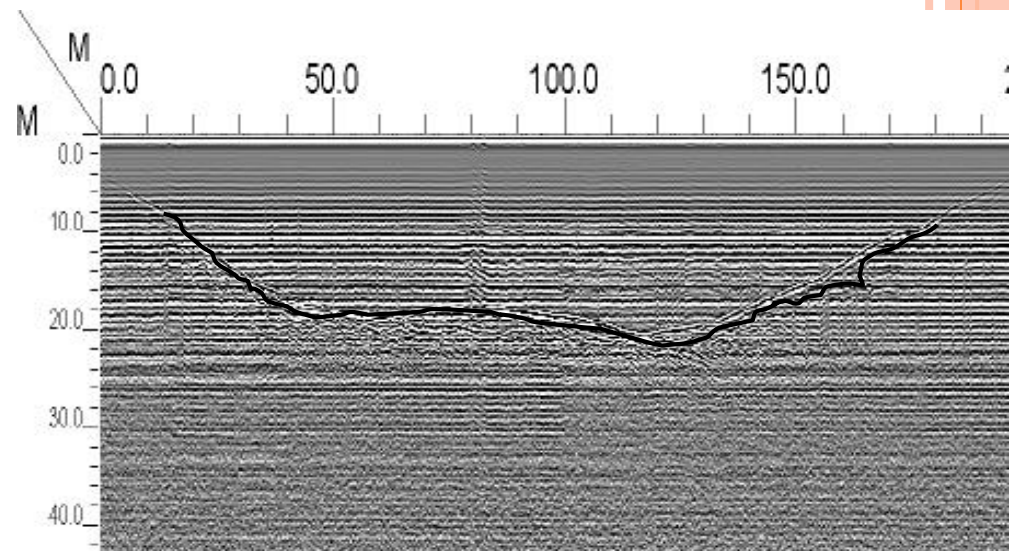
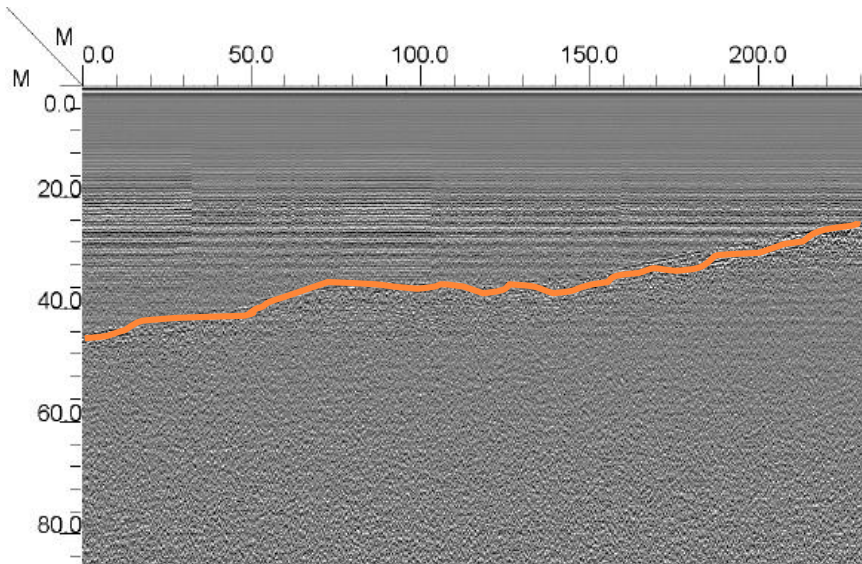
VESTRE BROGGERBREEN GLACIER



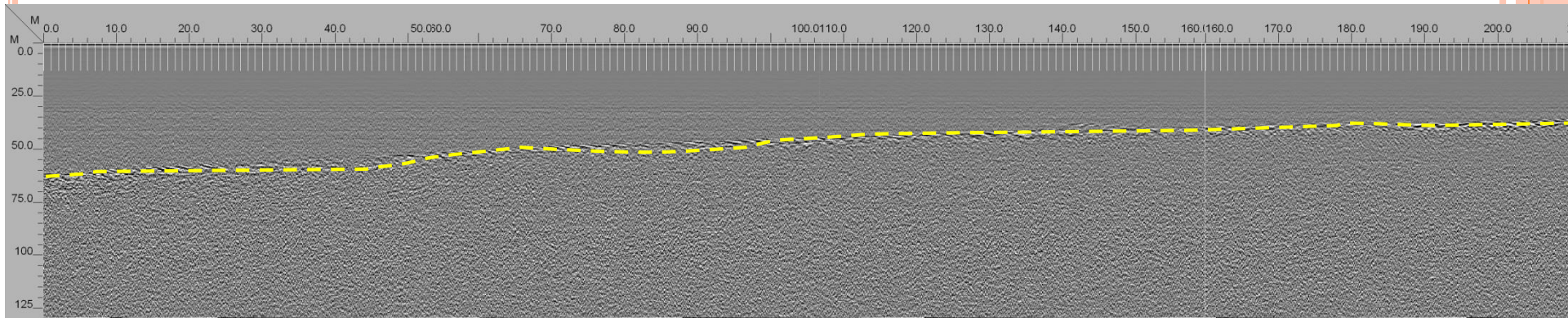
VB GLACIER RESULTS – GPR STUDIES



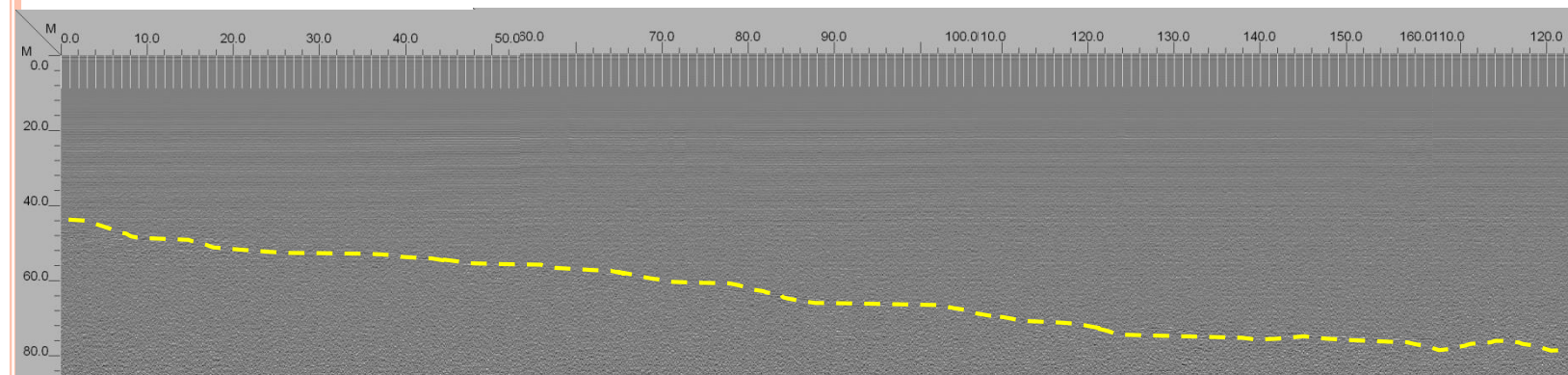
maximum depth of VB1 ~95 m while that of VB2 is ~105 m.



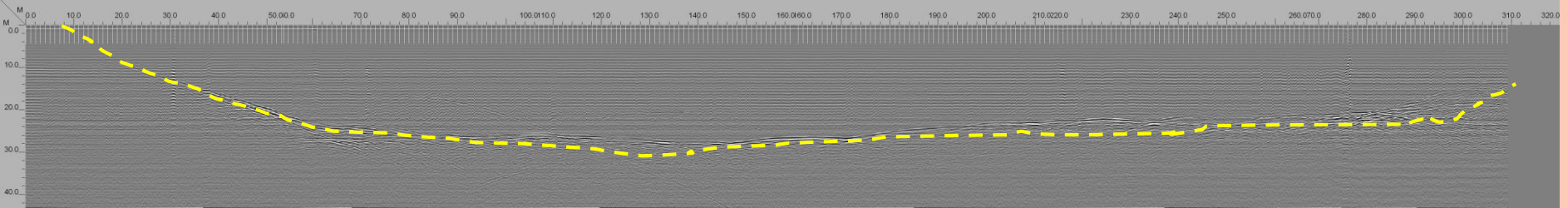
MORE GPR PROFILES



MORE GPR PROFILES

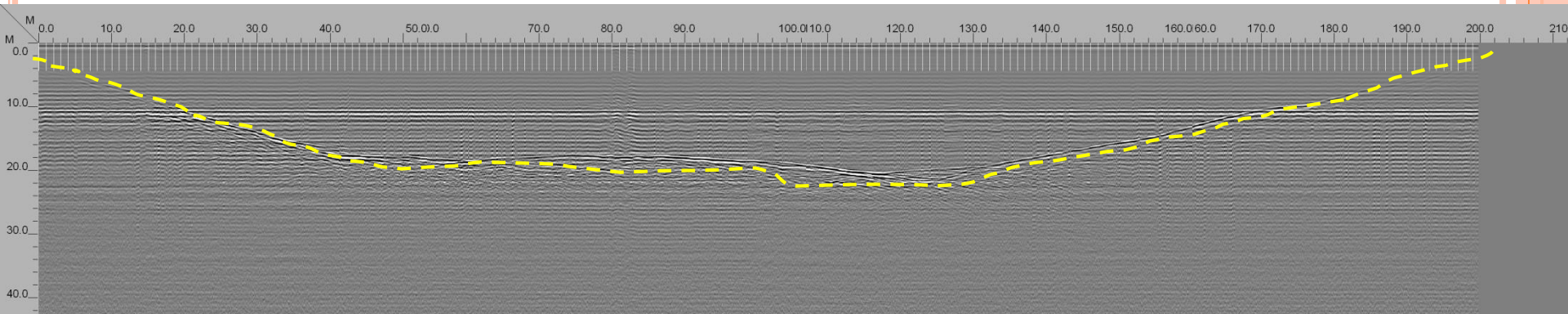


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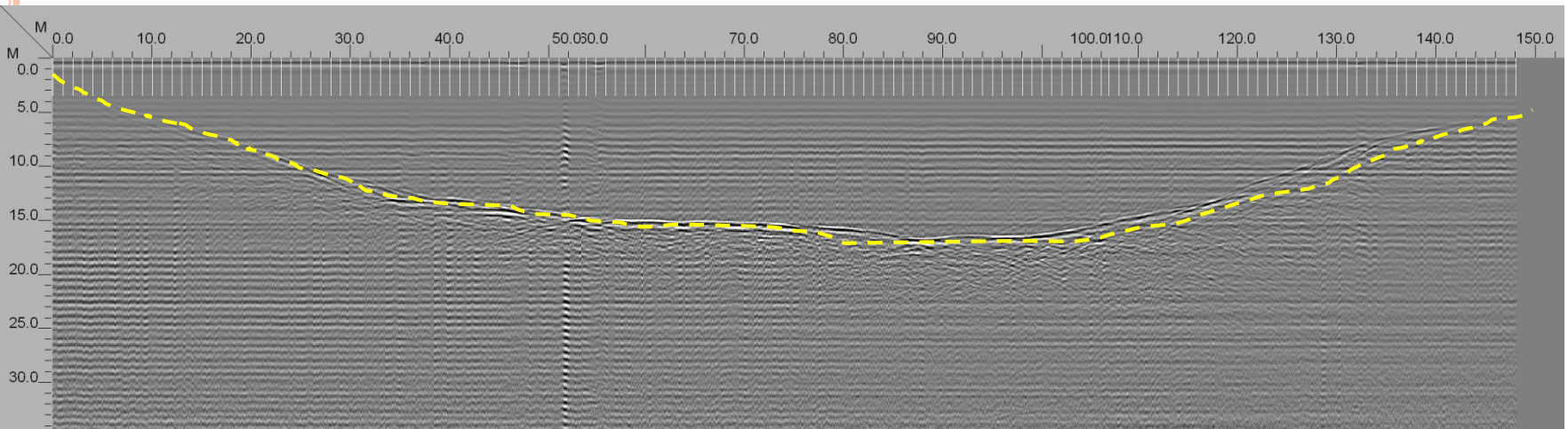


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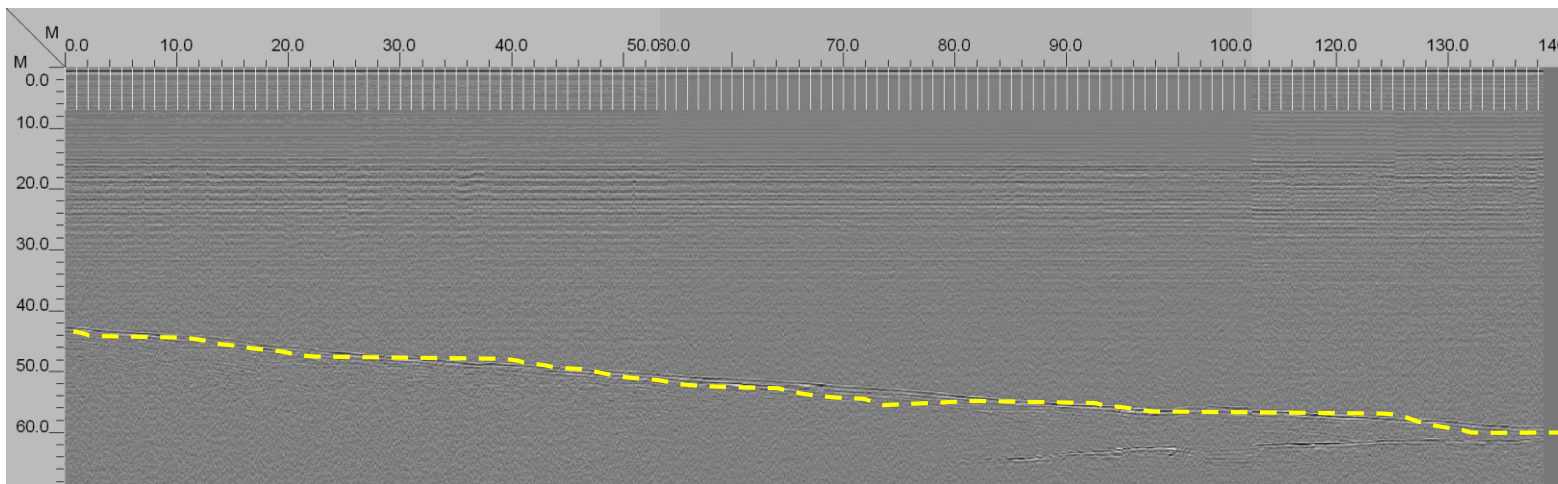


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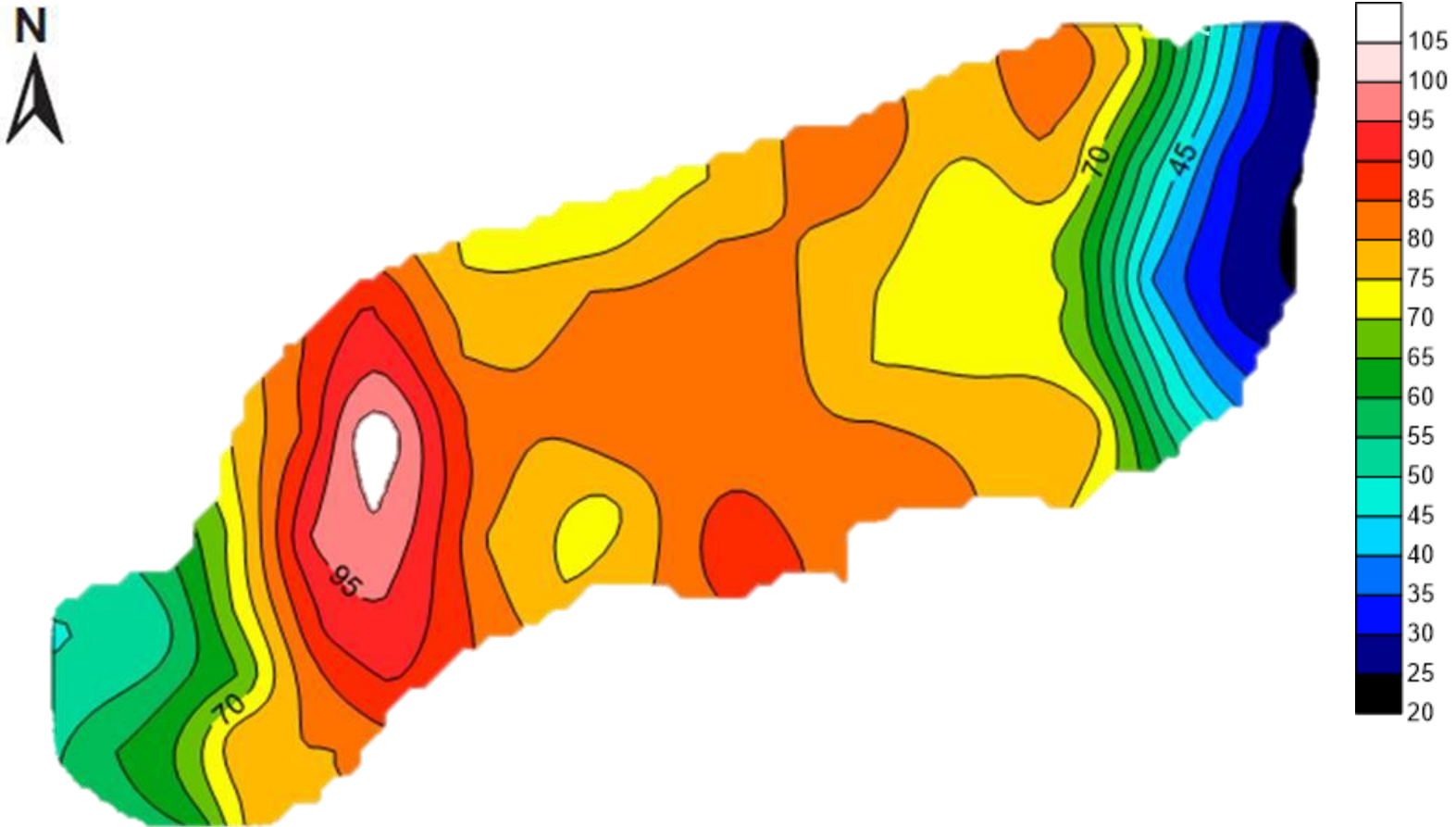


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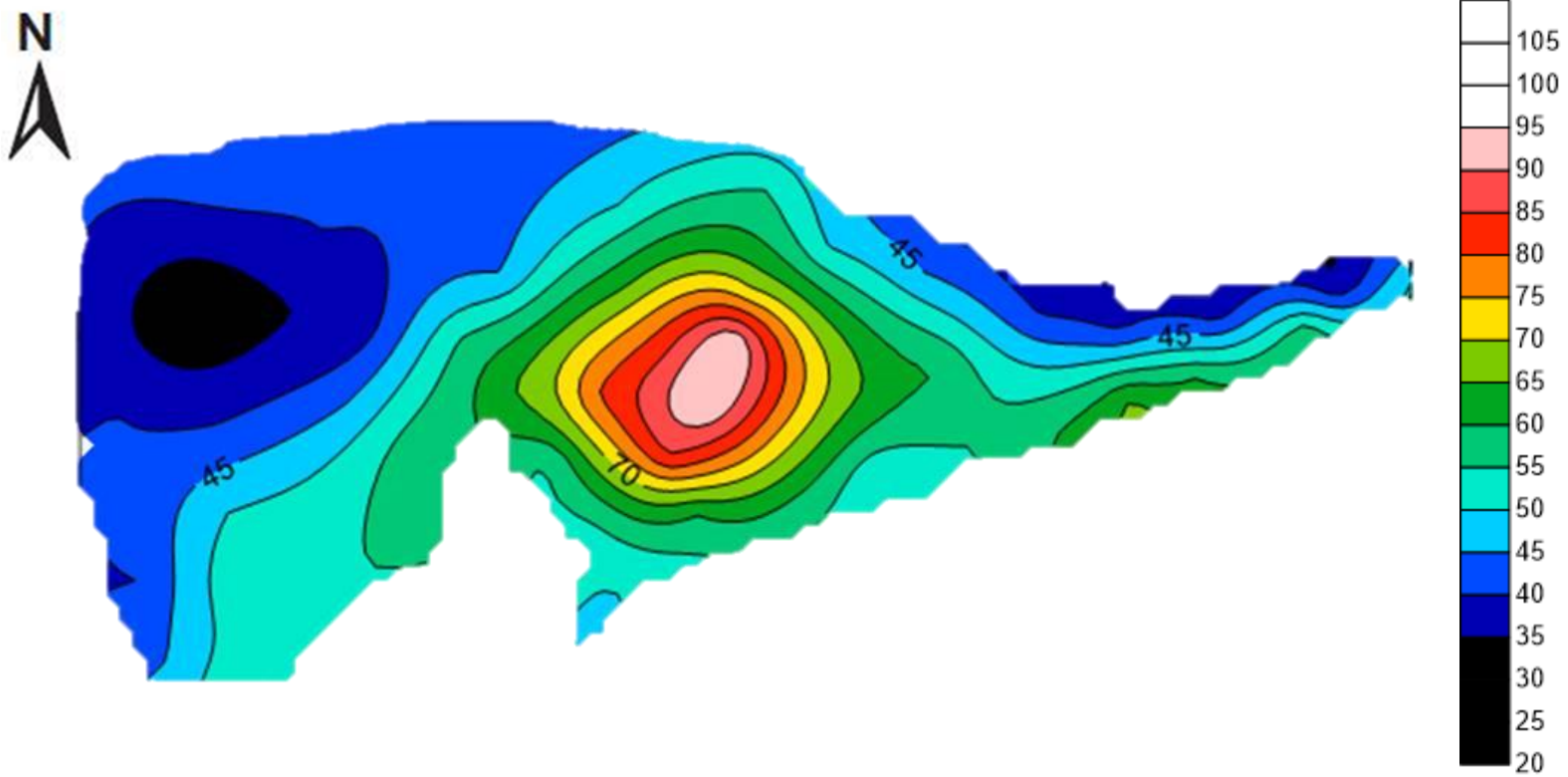
VV5001



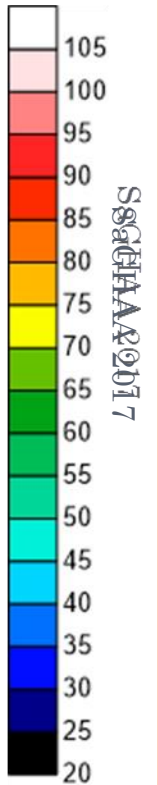
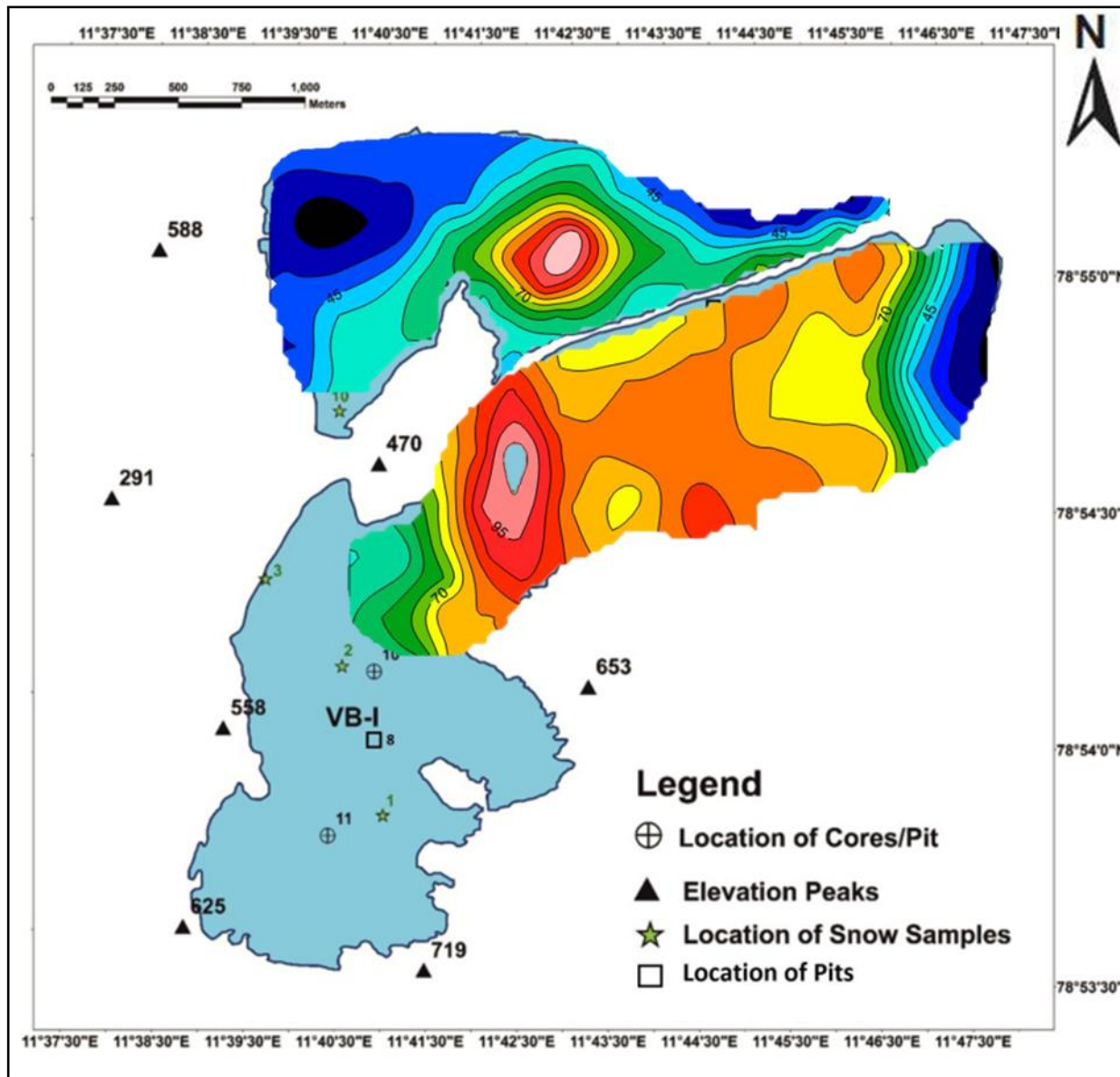
ICE THICKNESS MAP VB-I



ICE THICKNESS MAP VB-II



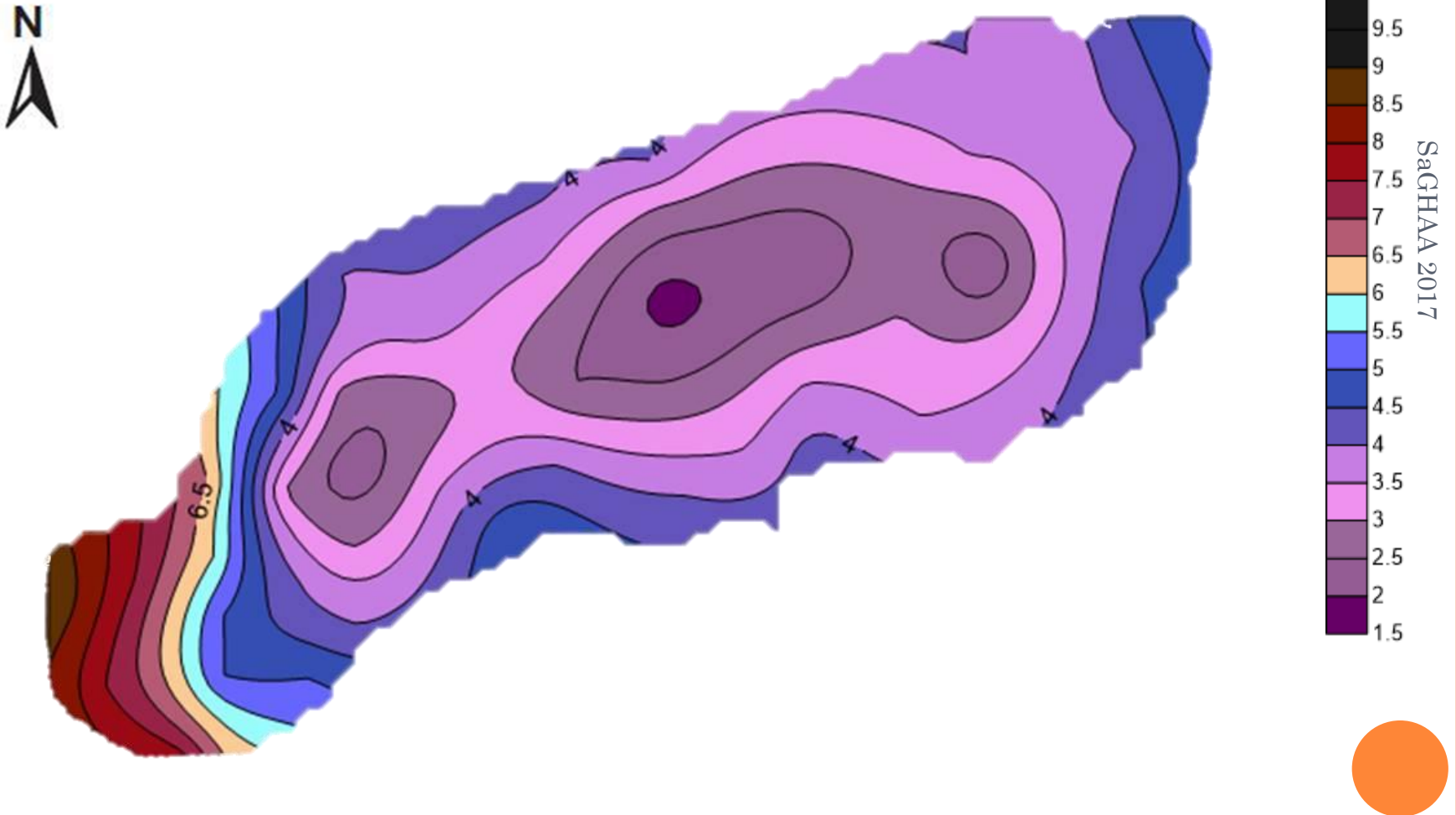
ICE THICKNESS



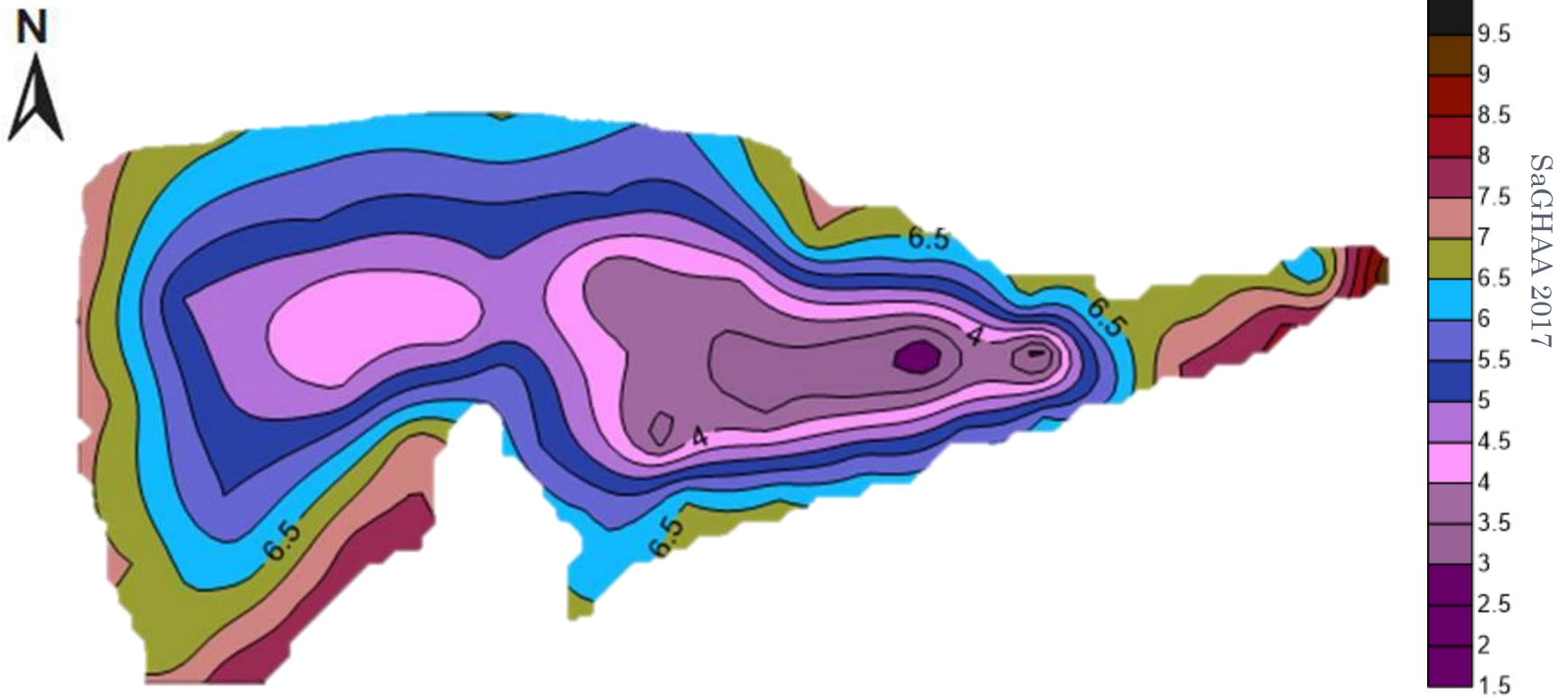
SSGTHAR2017



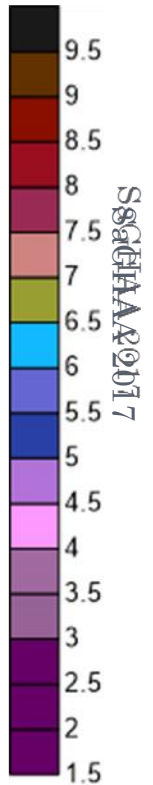
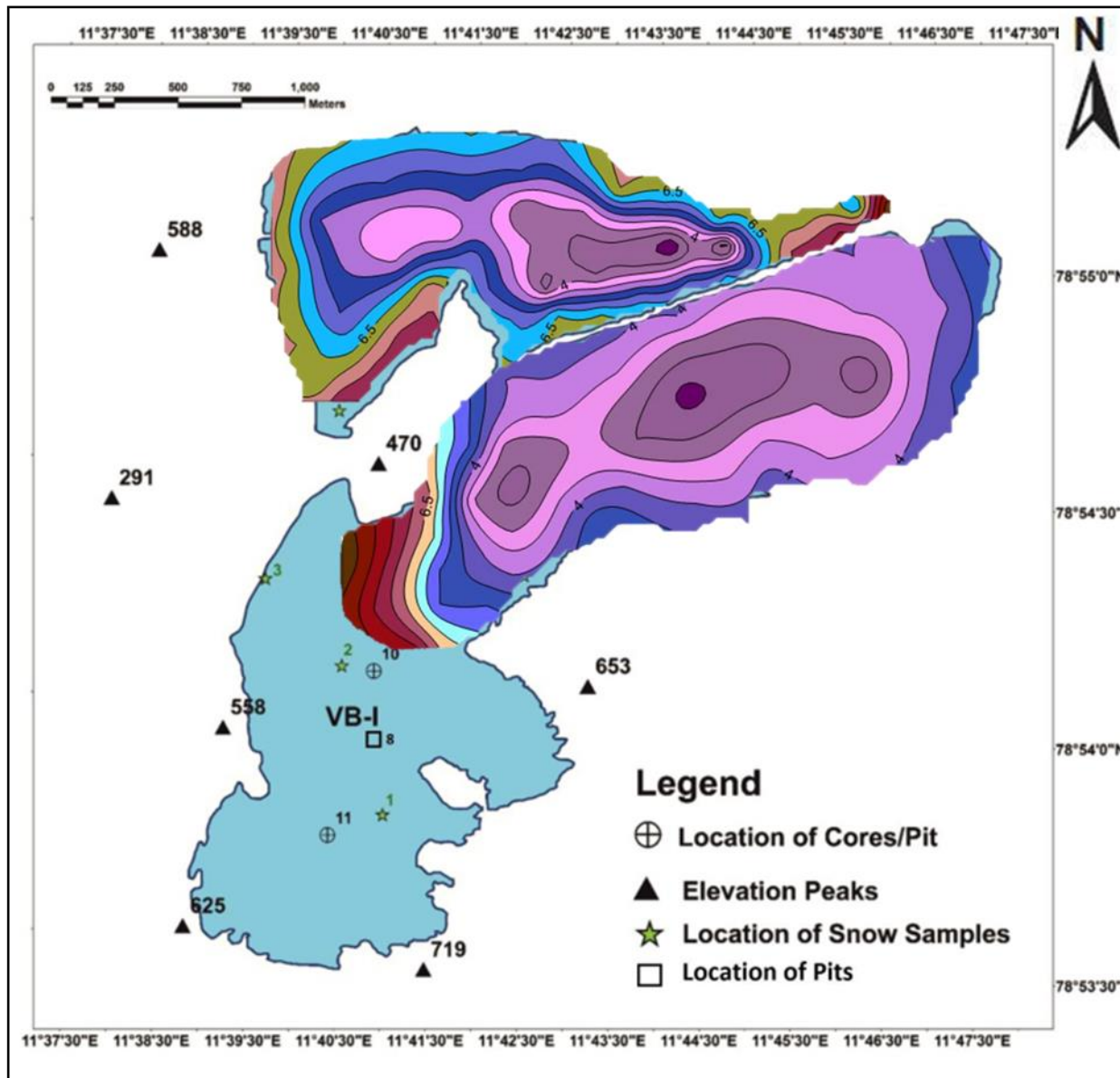
SURFACE SLOPE MAP VB-I



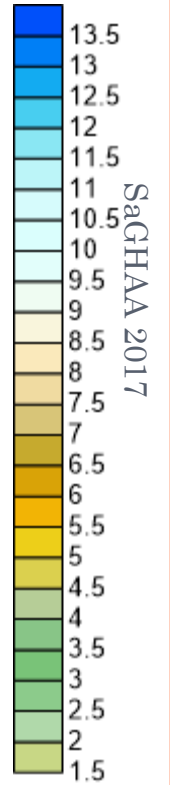
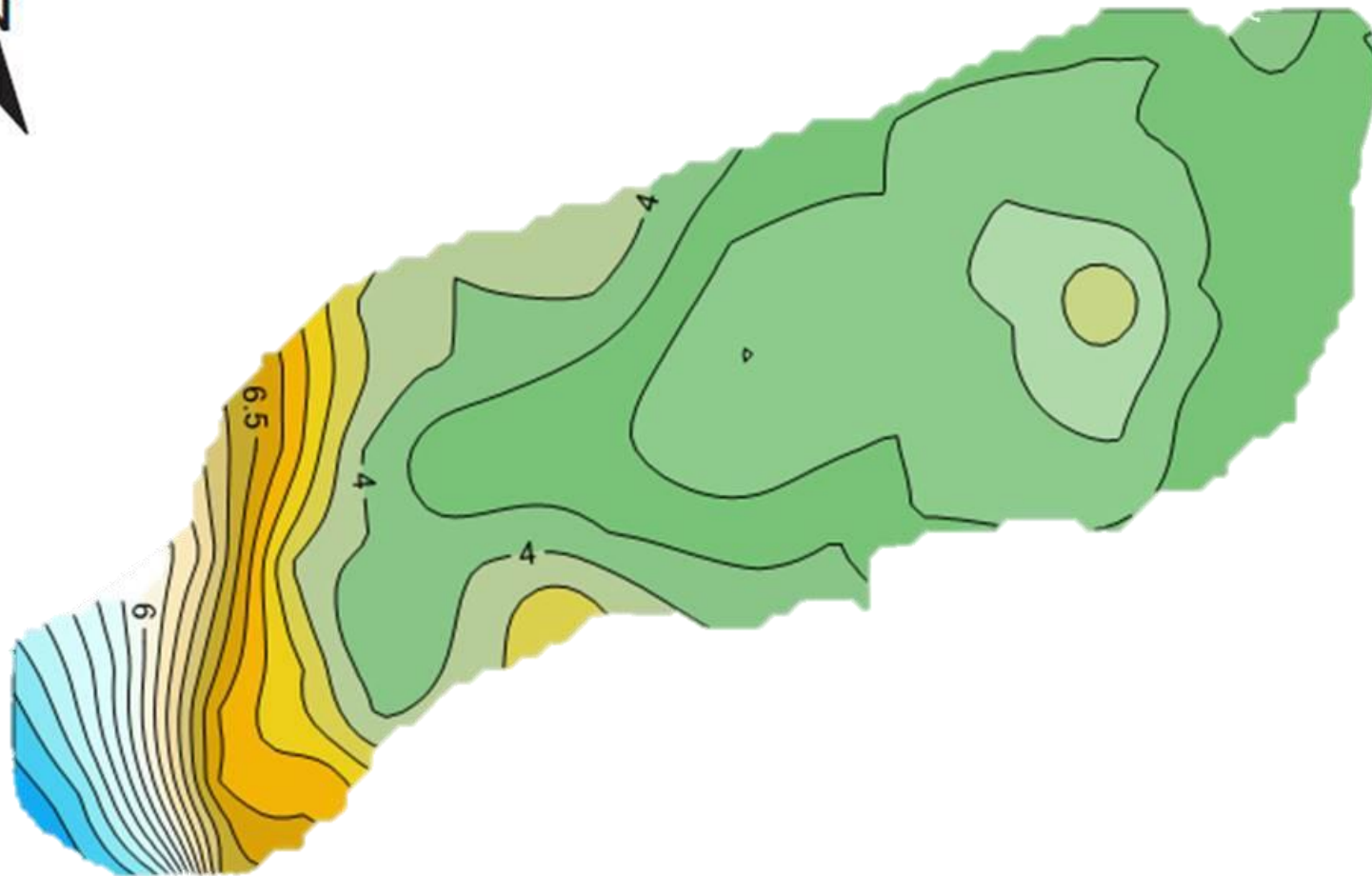
SURFACE SLOPE MAP VB-II

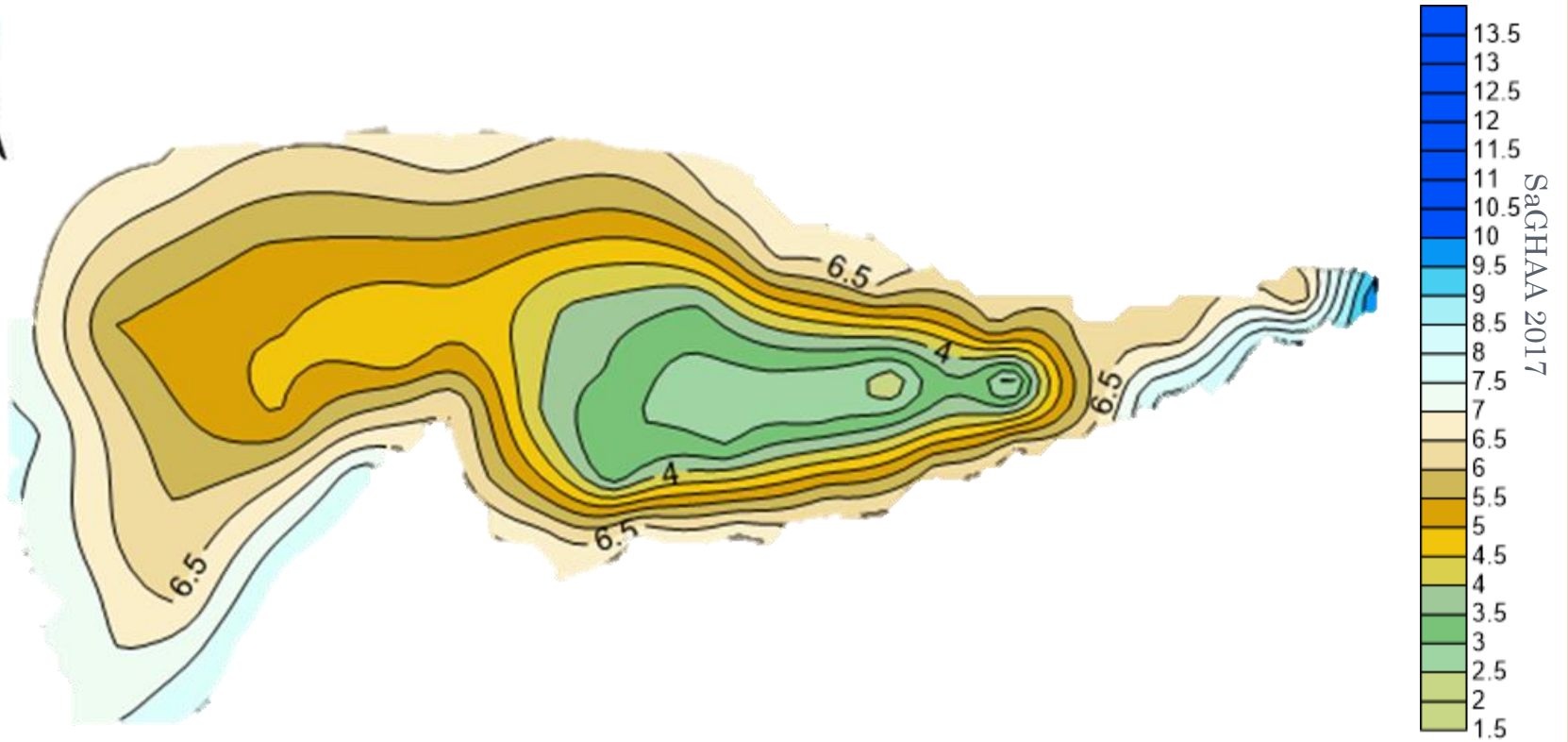


SURFACE SLOPE

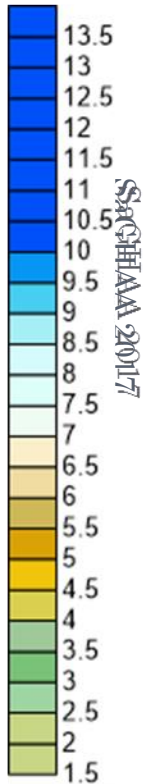
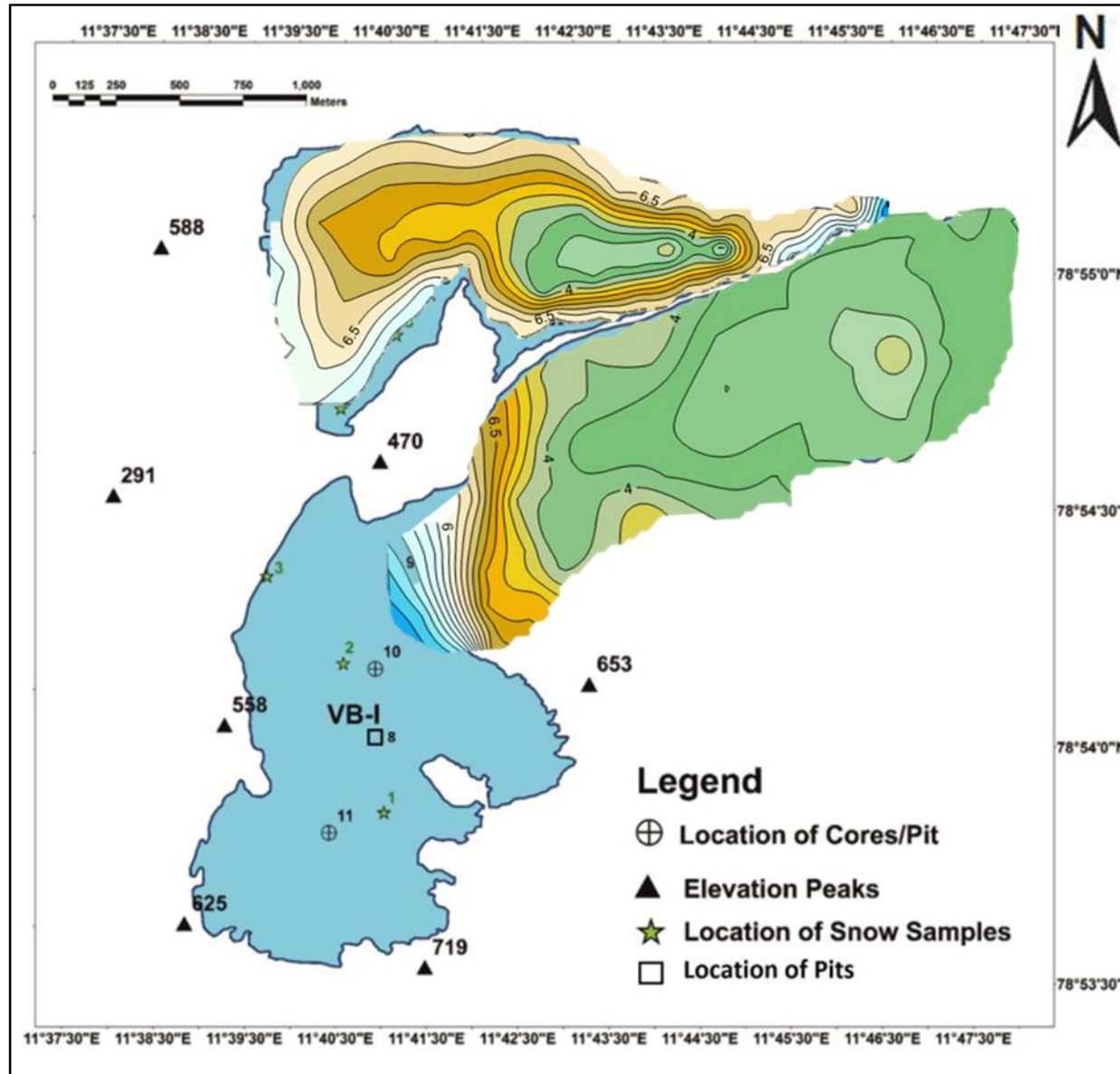


BEDROCK SLOPE MAP VB-I

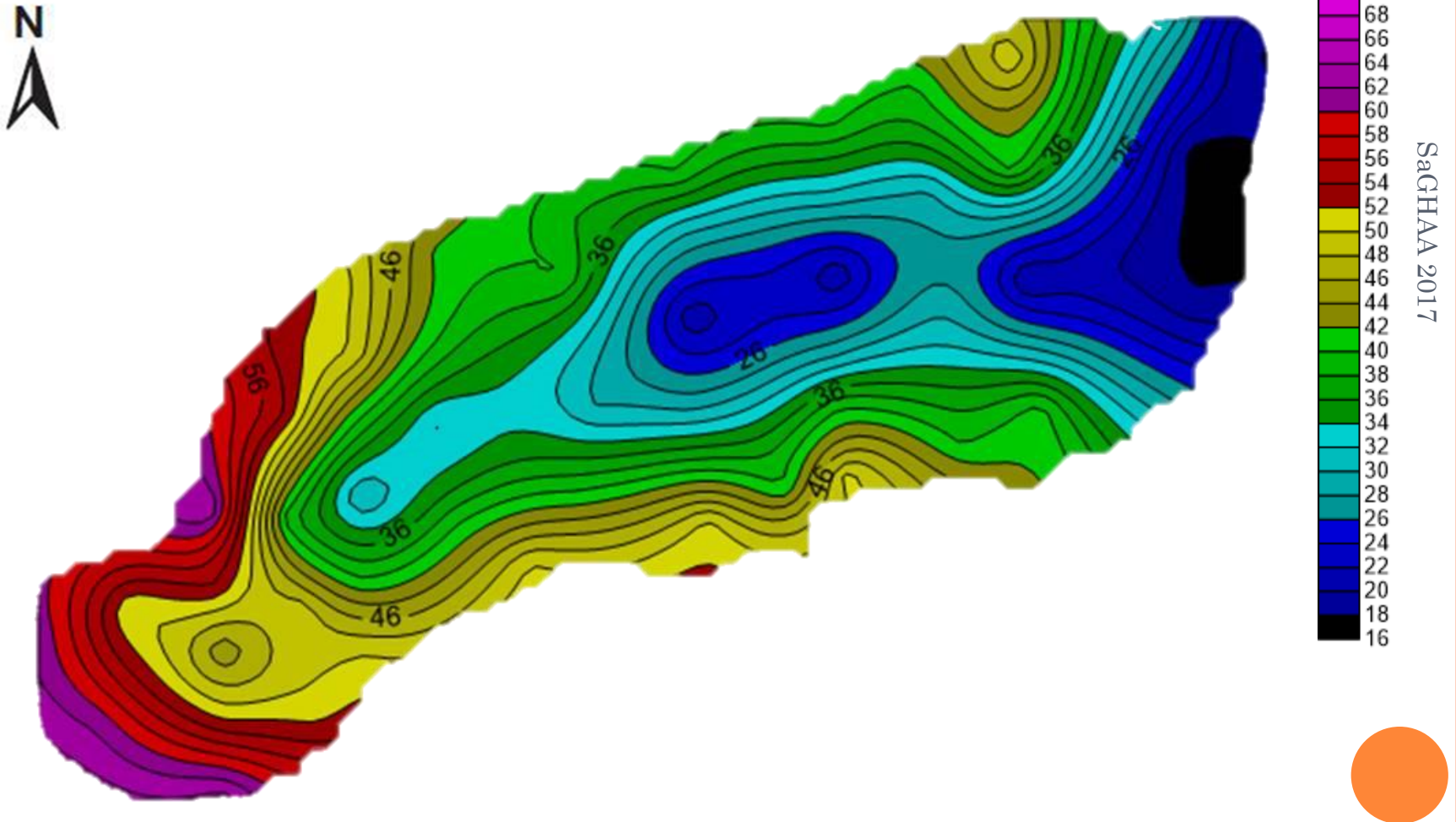




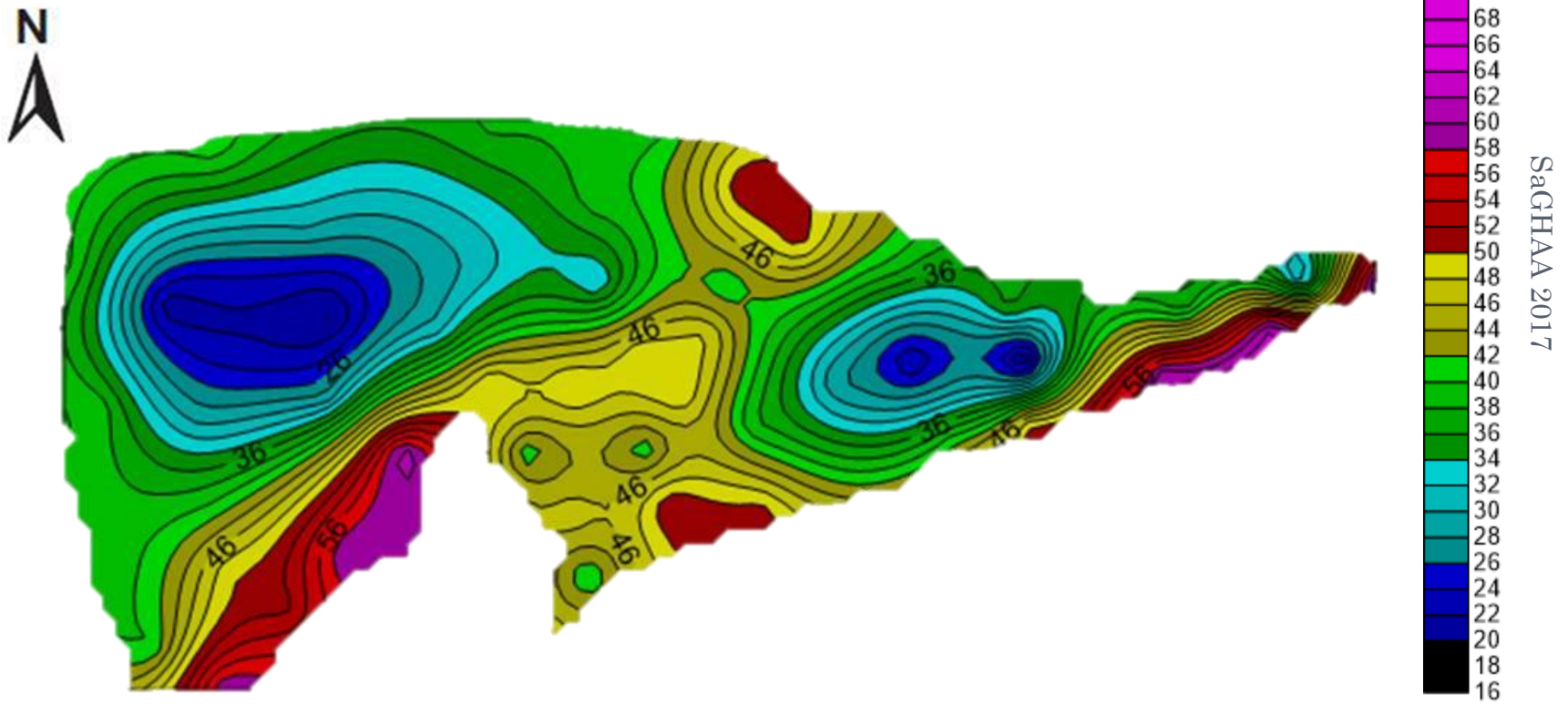
BEDROCK SLOPE



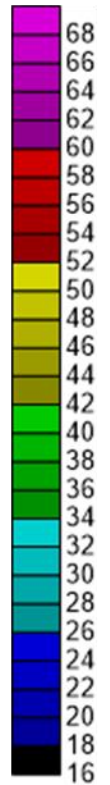
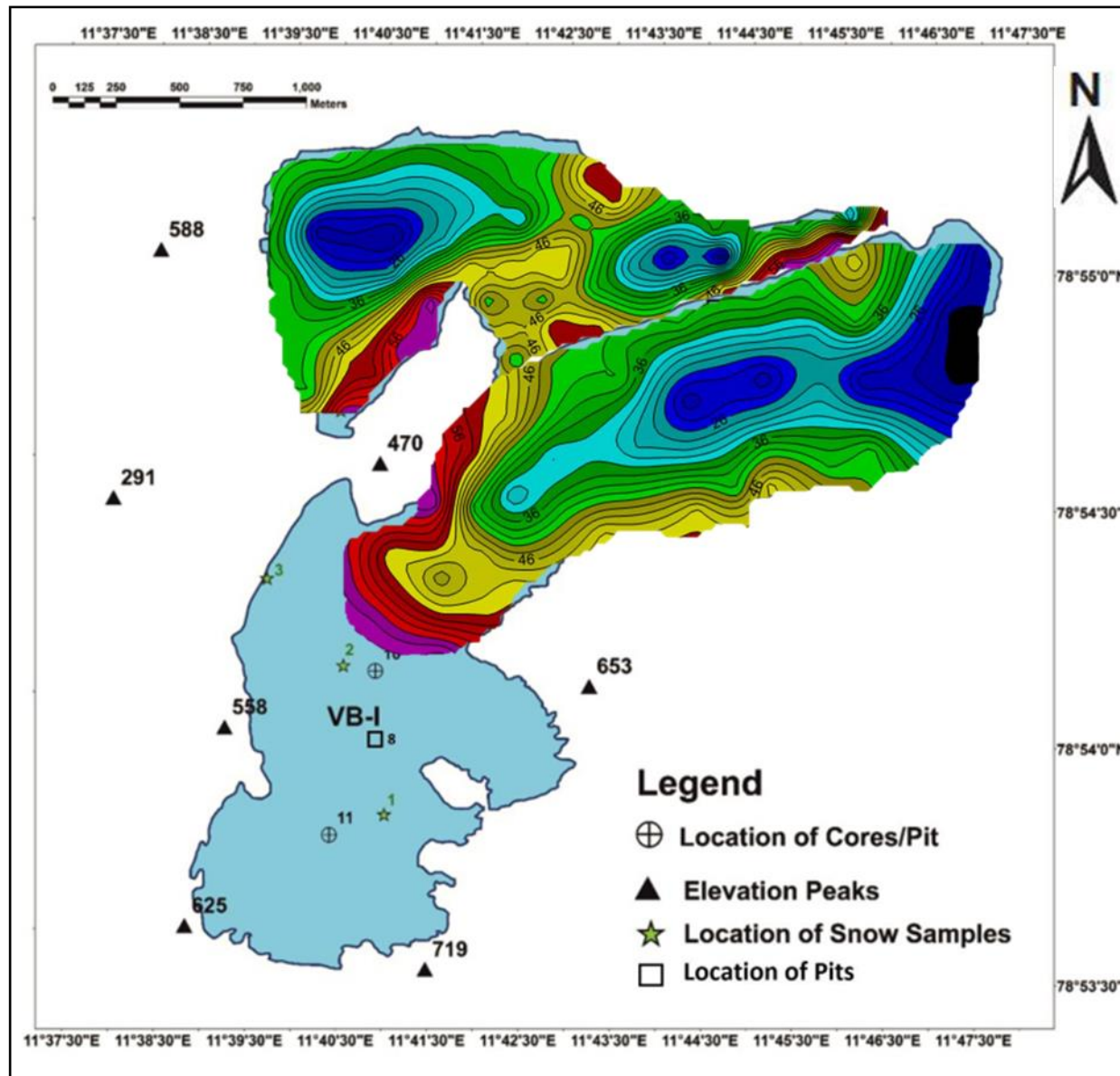
STRESS MAP VB-I



STRESS MAP VB-II

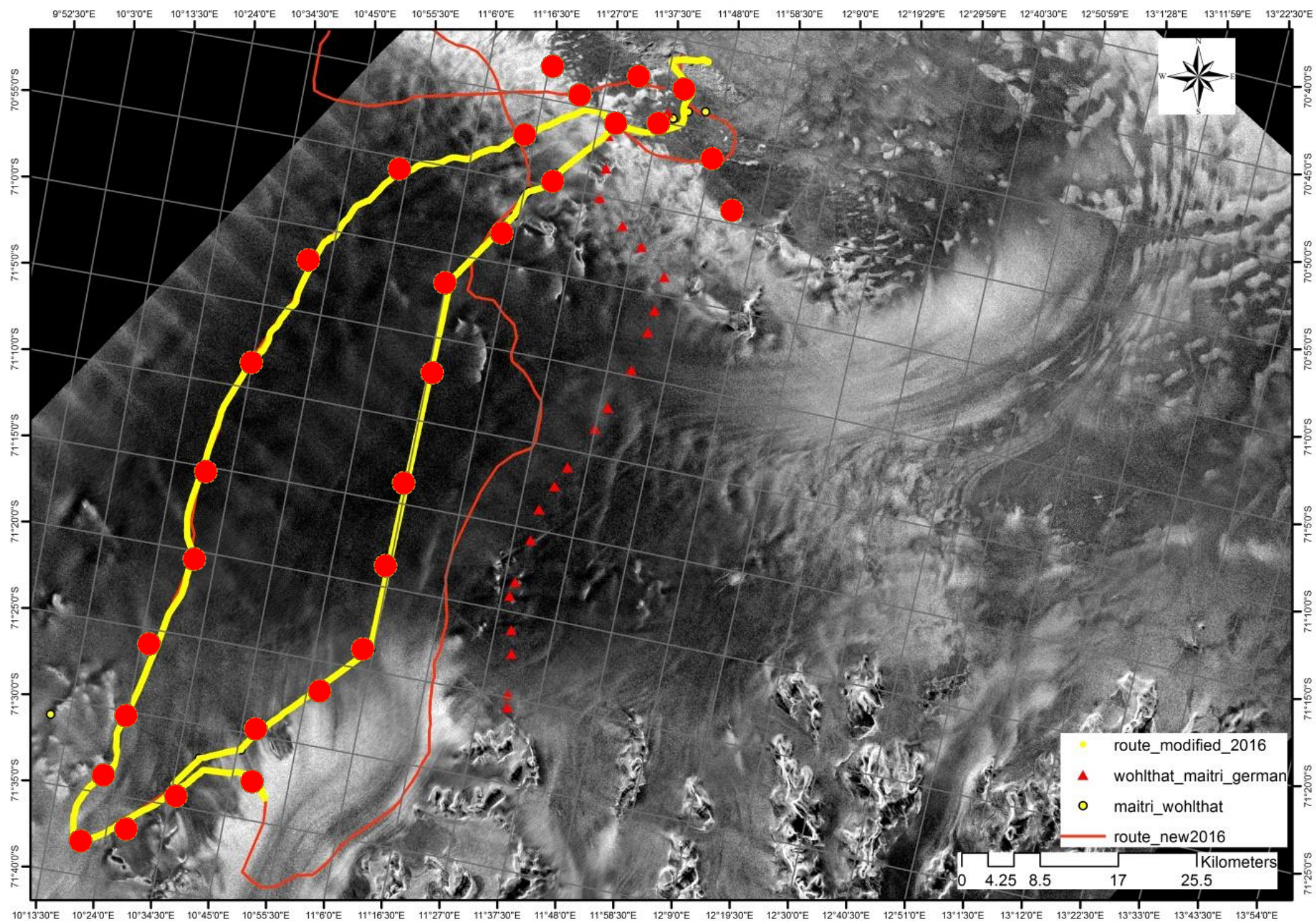


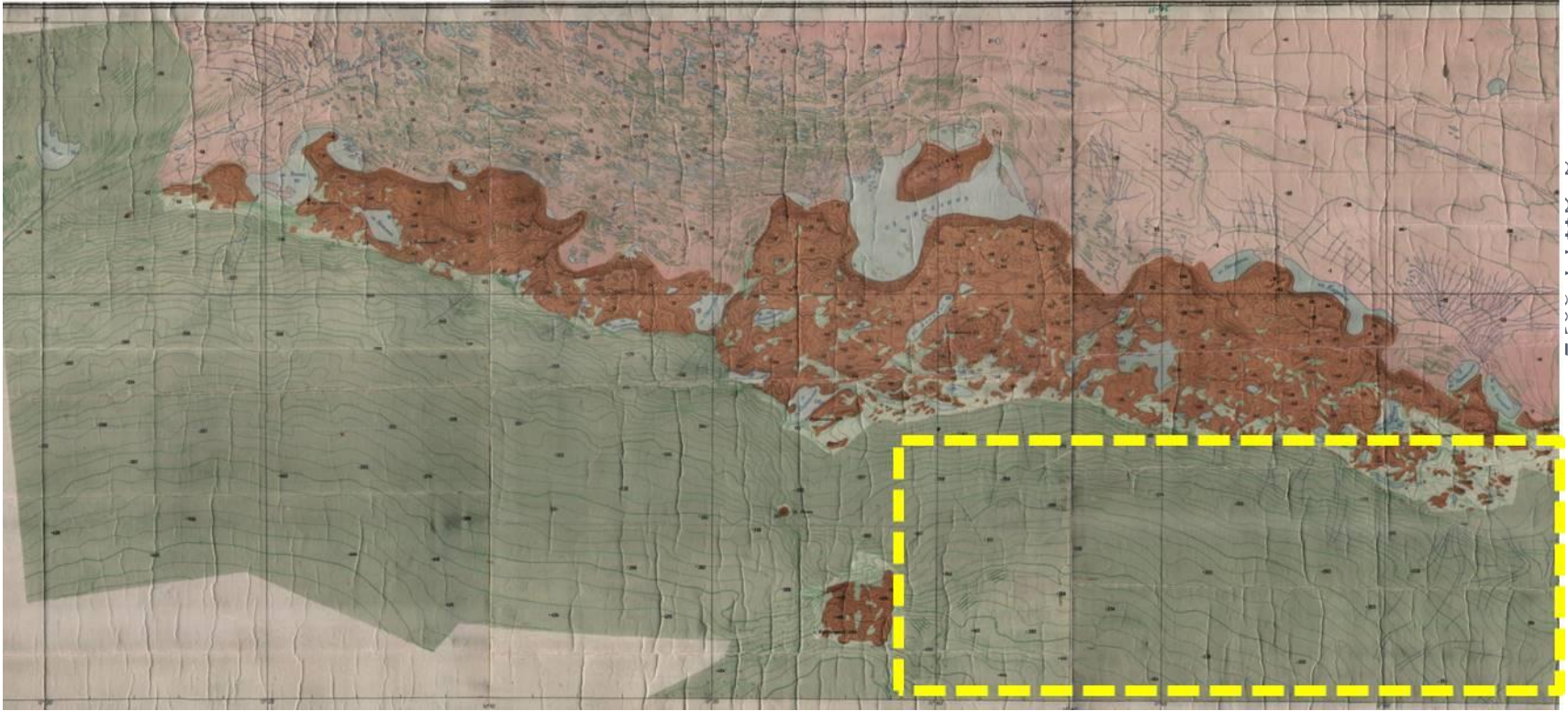
STRESS MAPPING



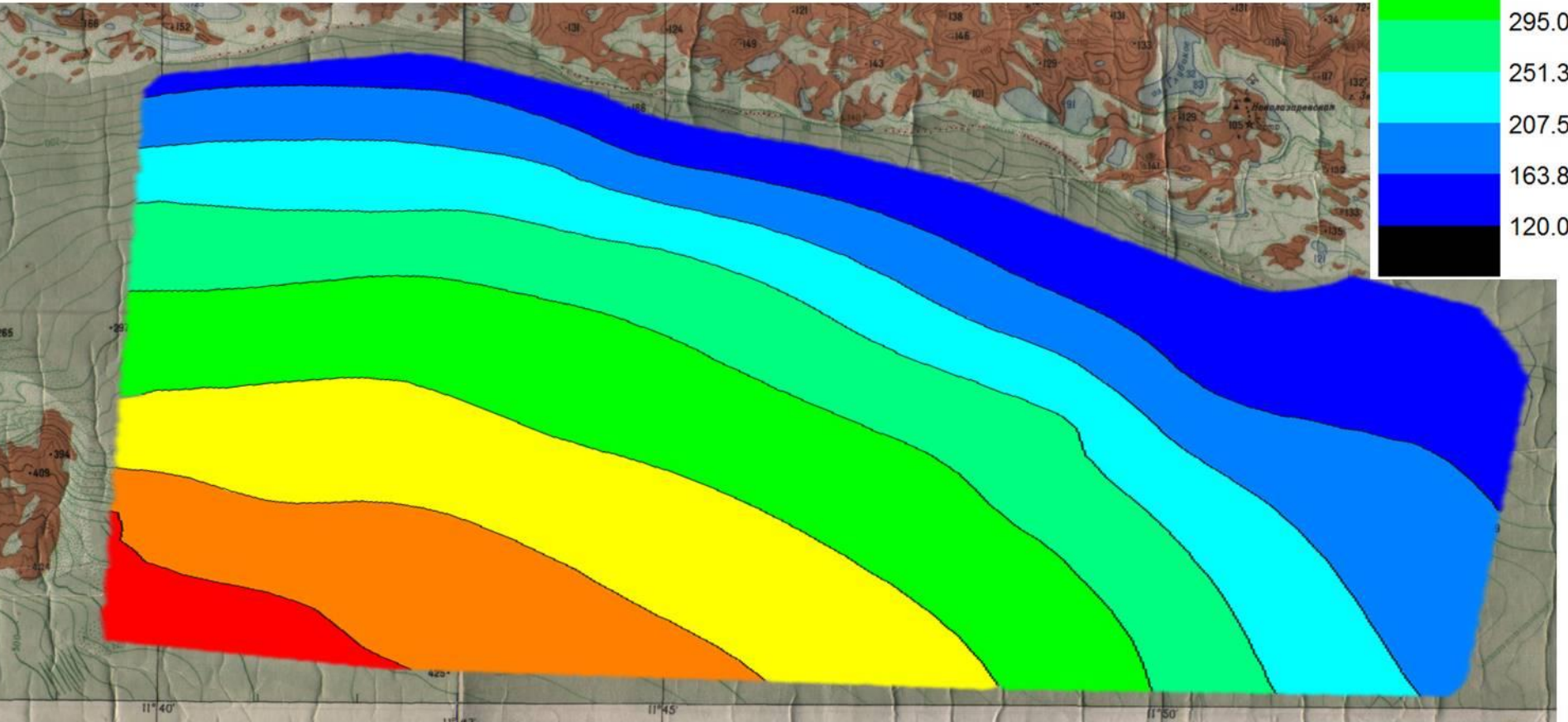
SSG/HAR/2017



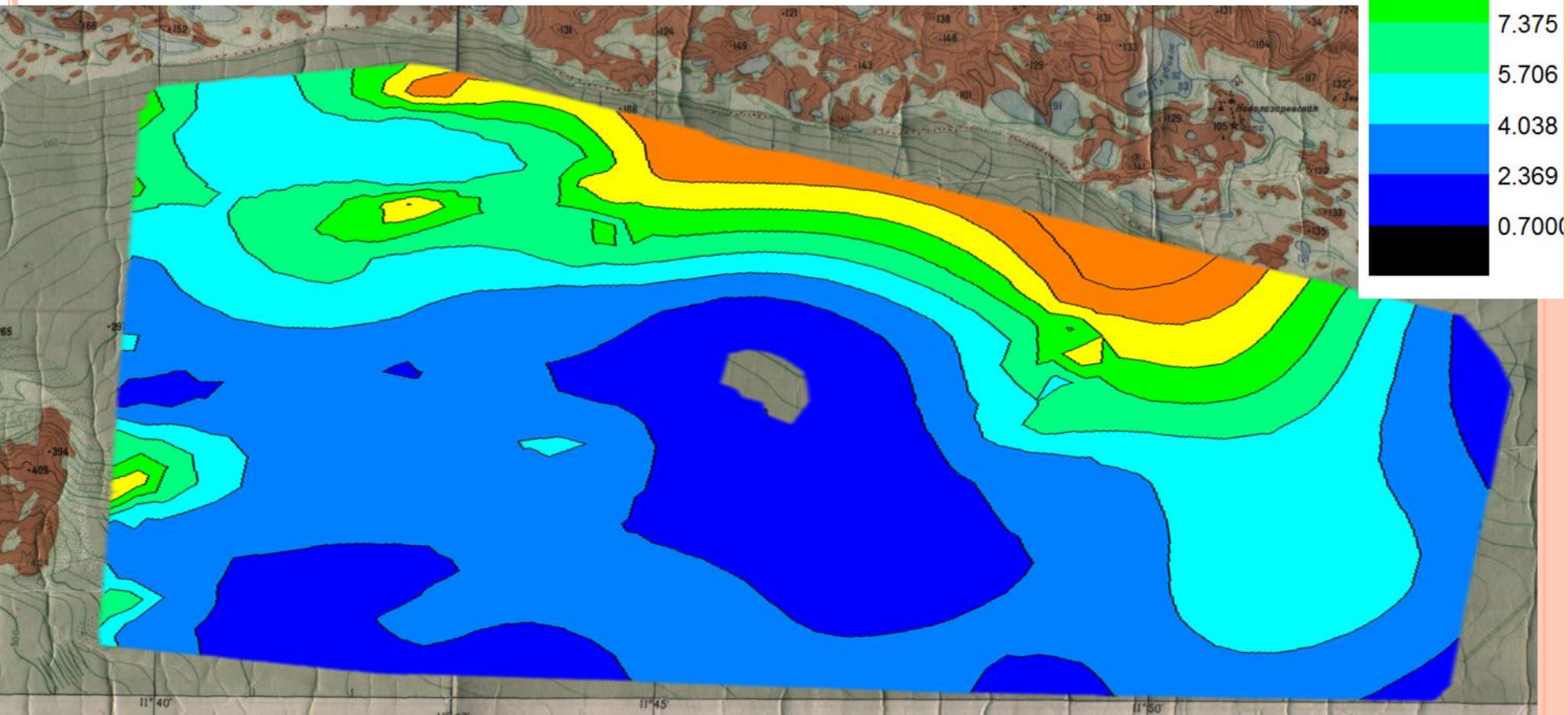




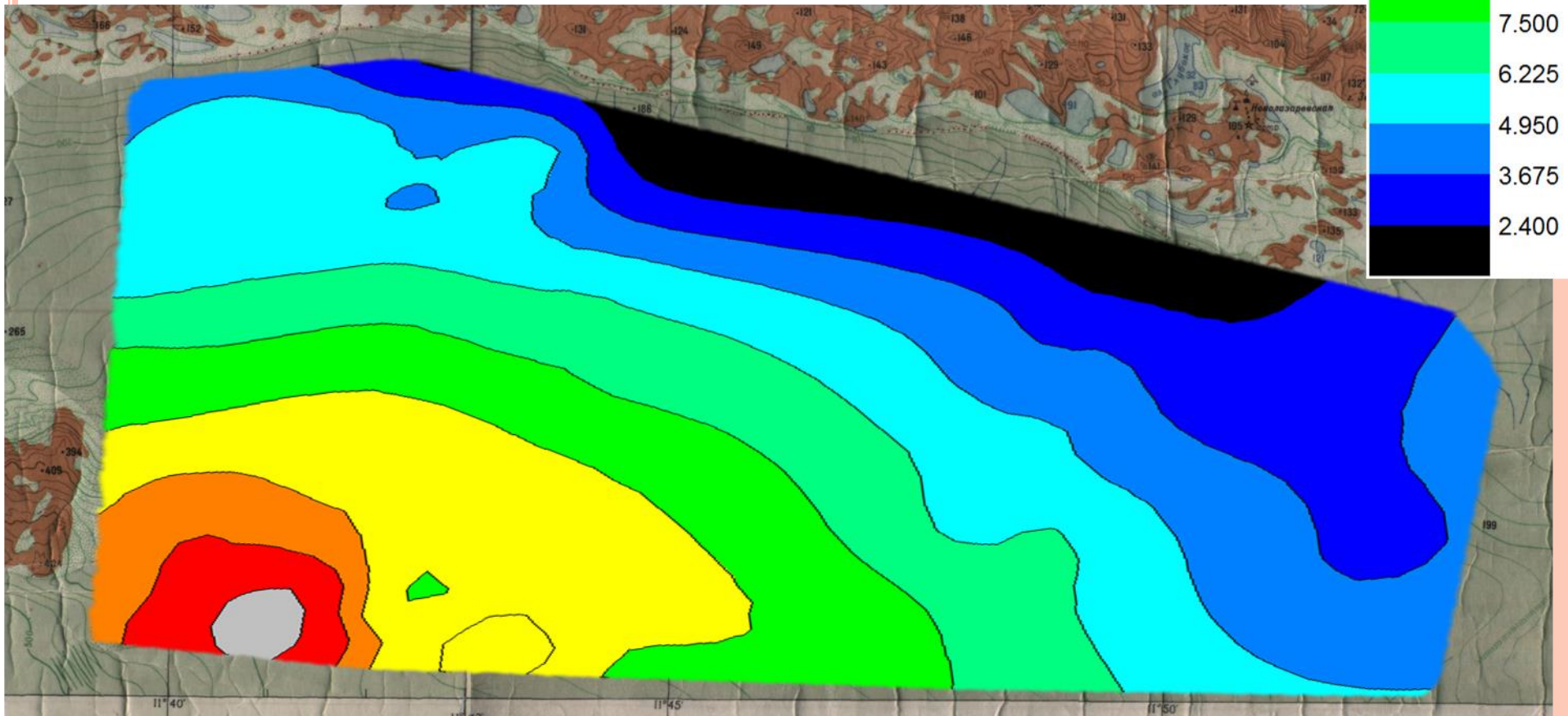
ELEVATION



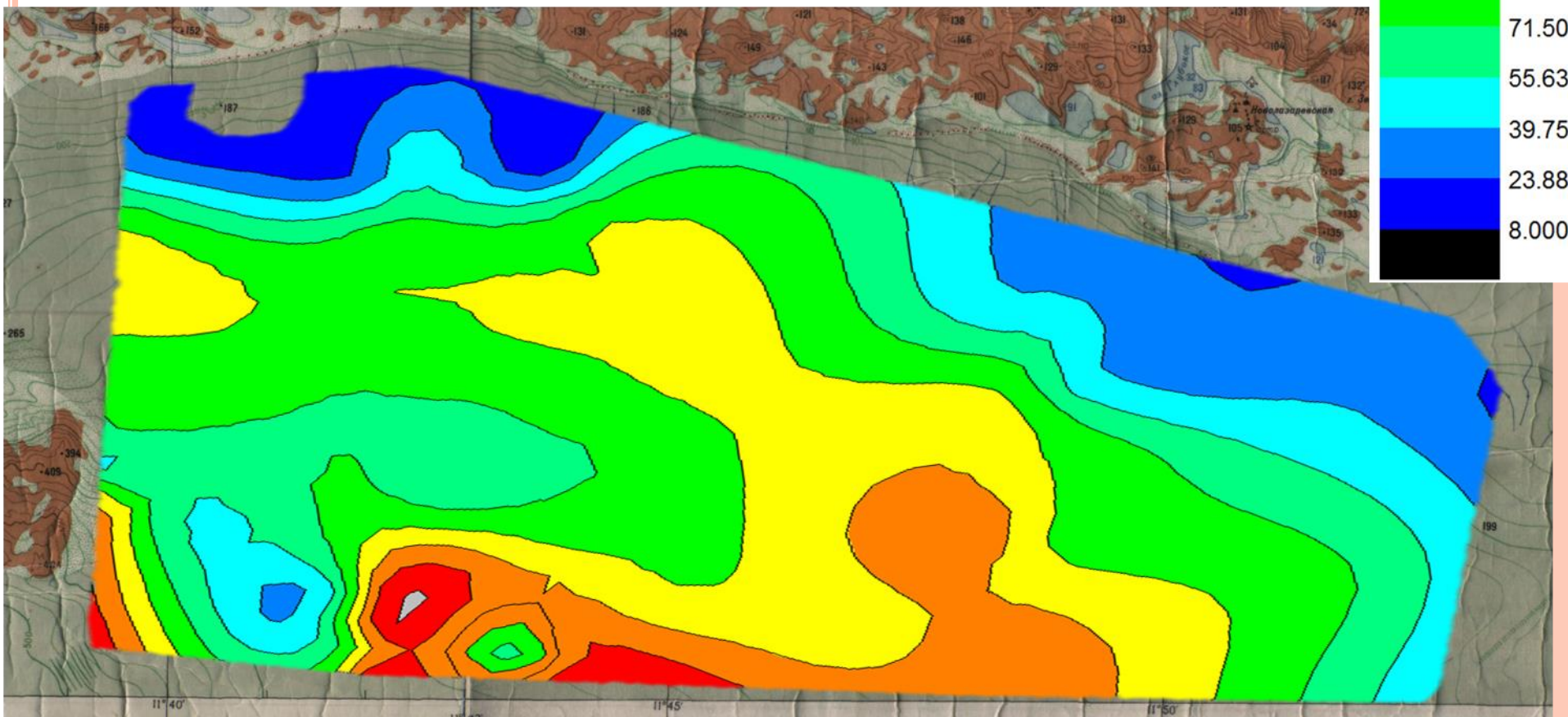
SURFACE SLOPE



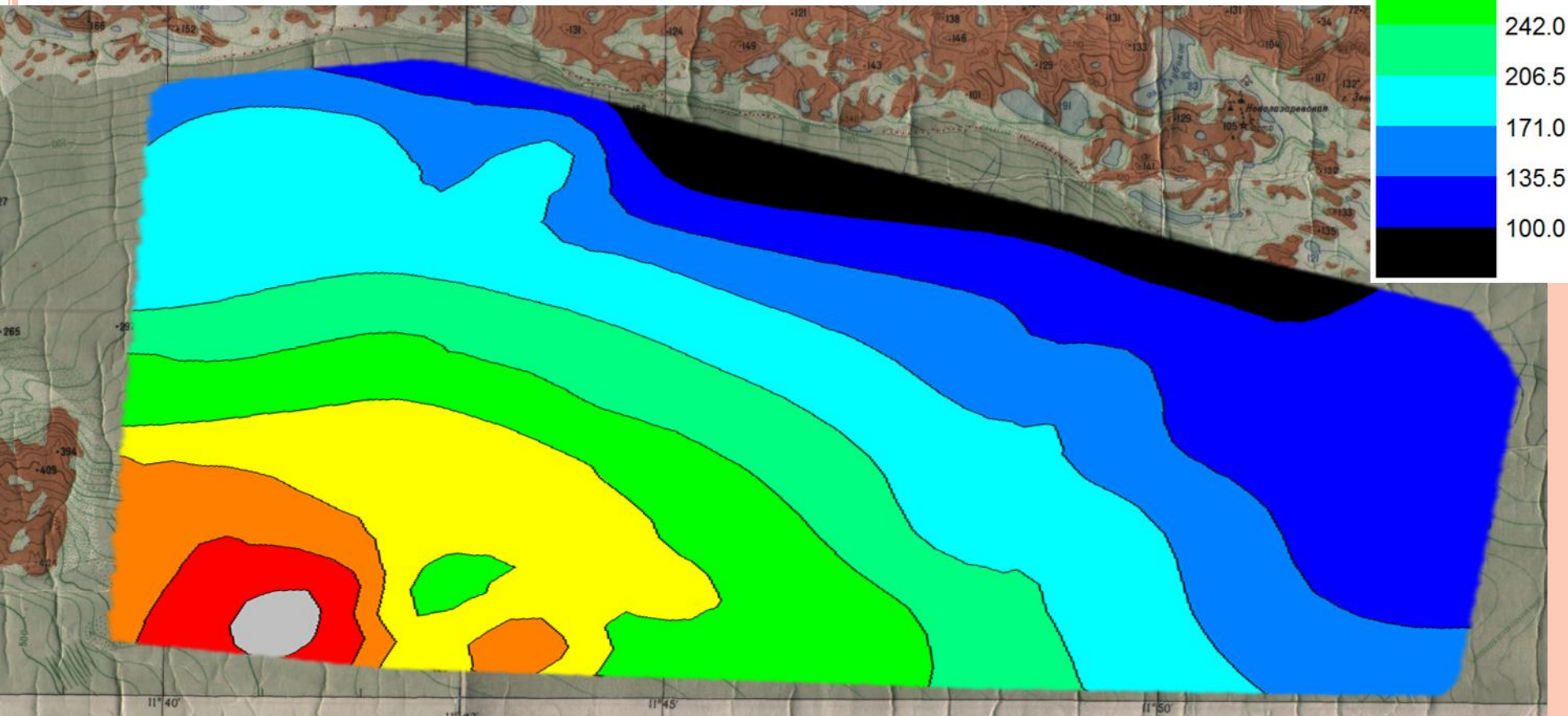
BEDROCK SLOPE



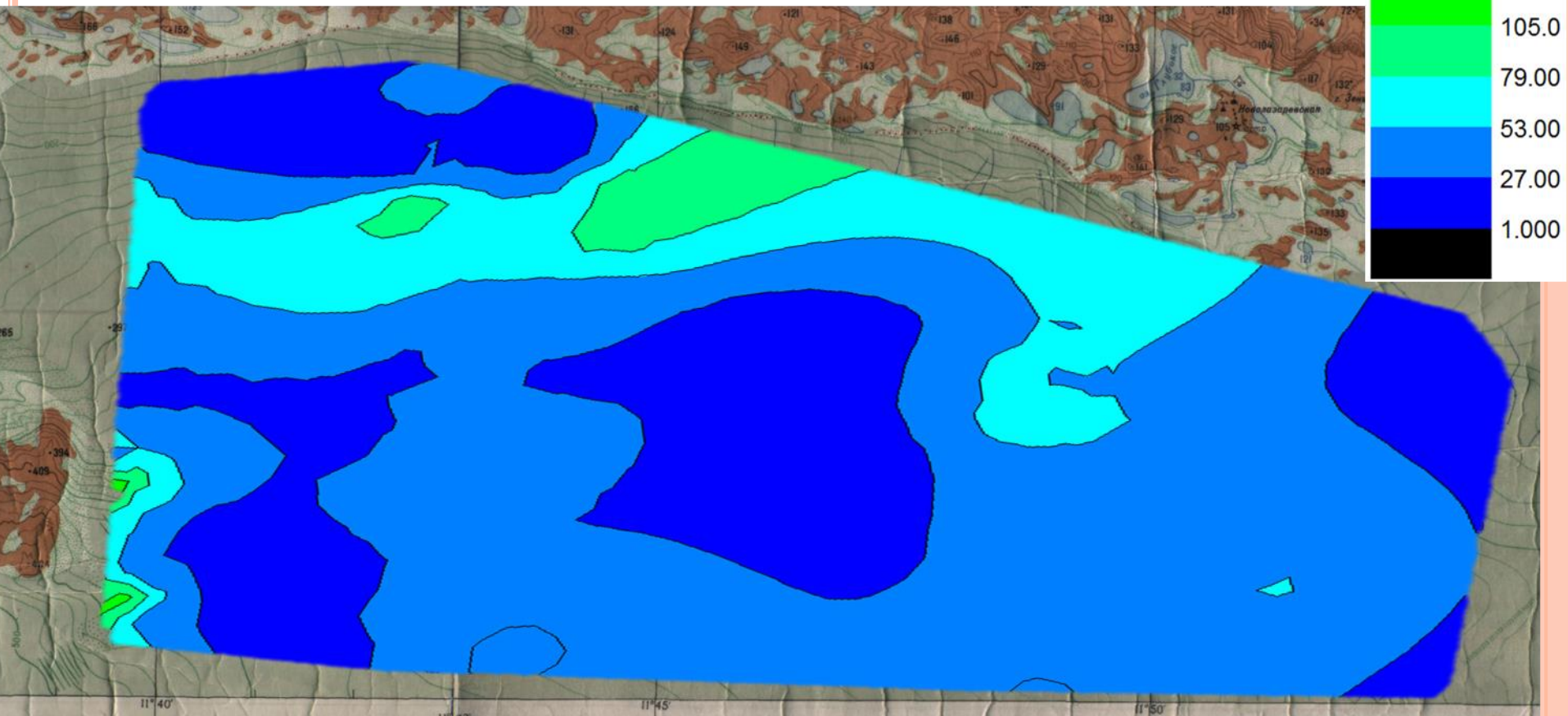
ICE THICKNESS



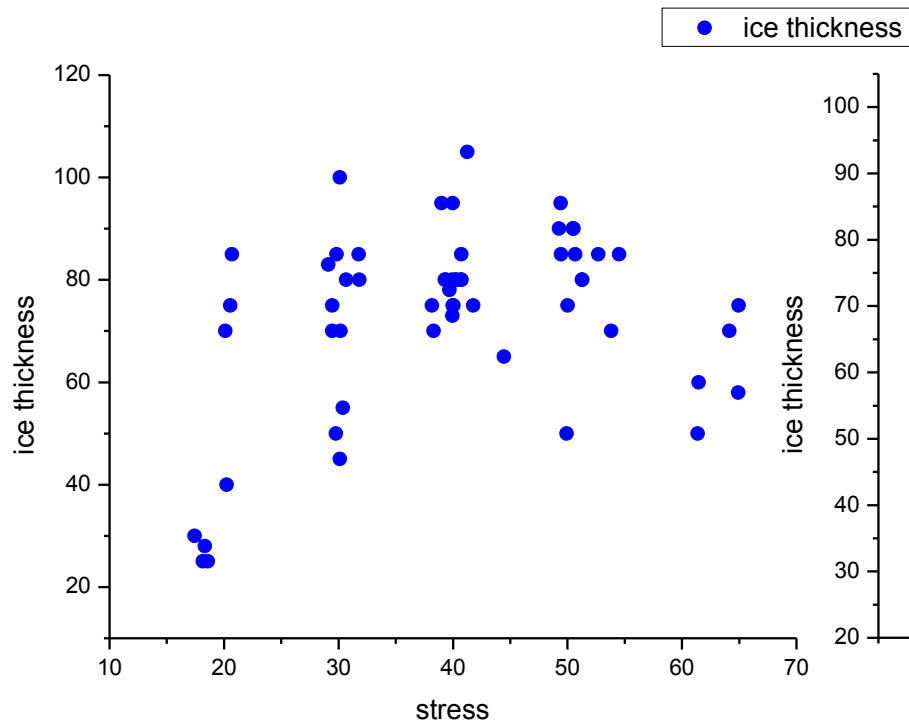
BED ELEVATION



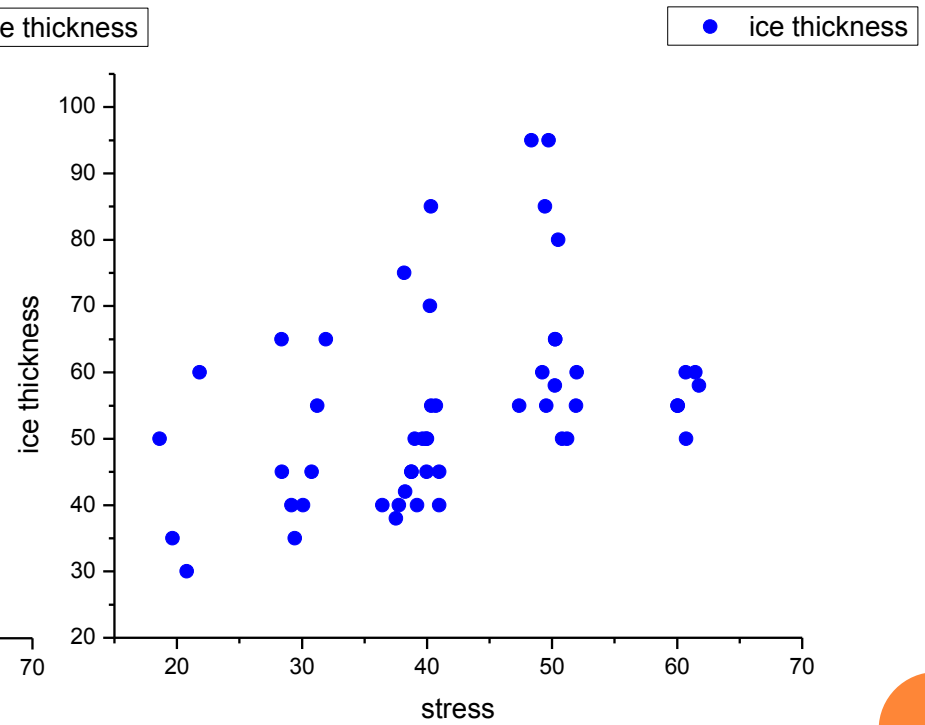
STRESS



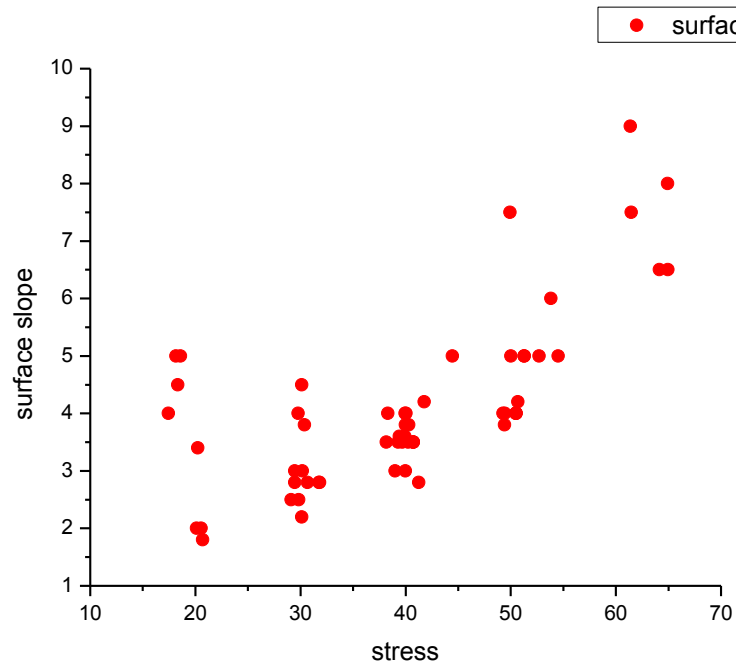
VB I



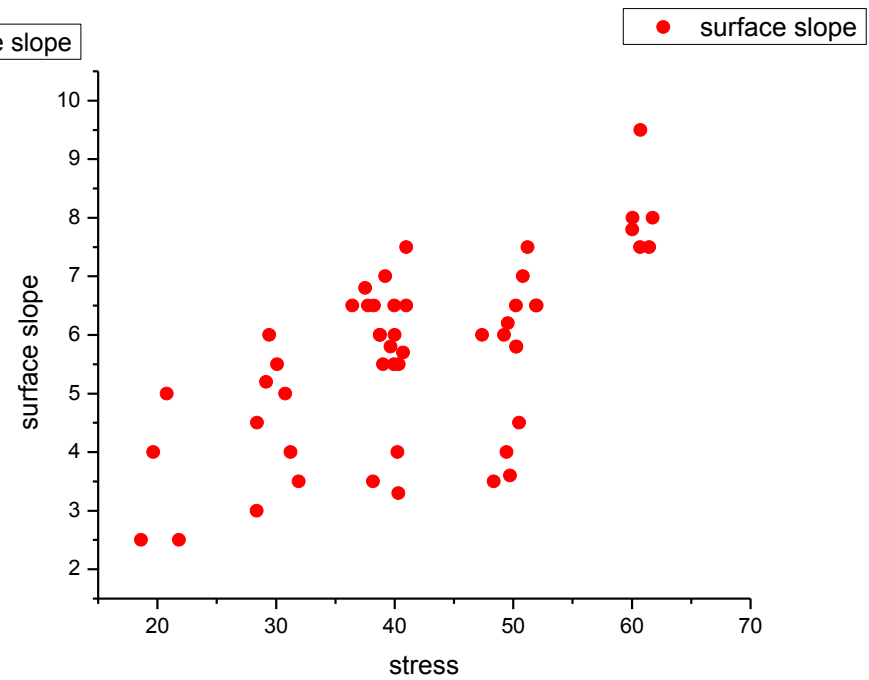
VB II



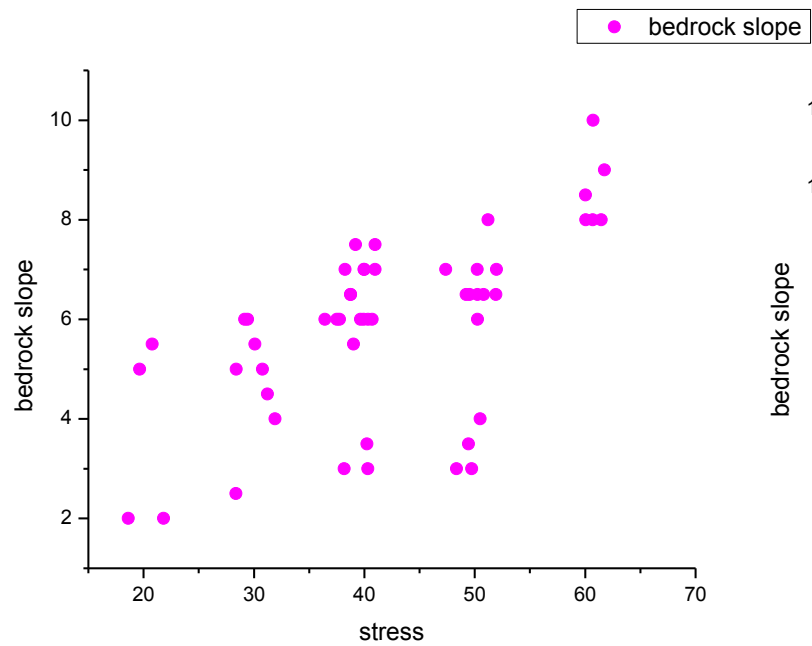
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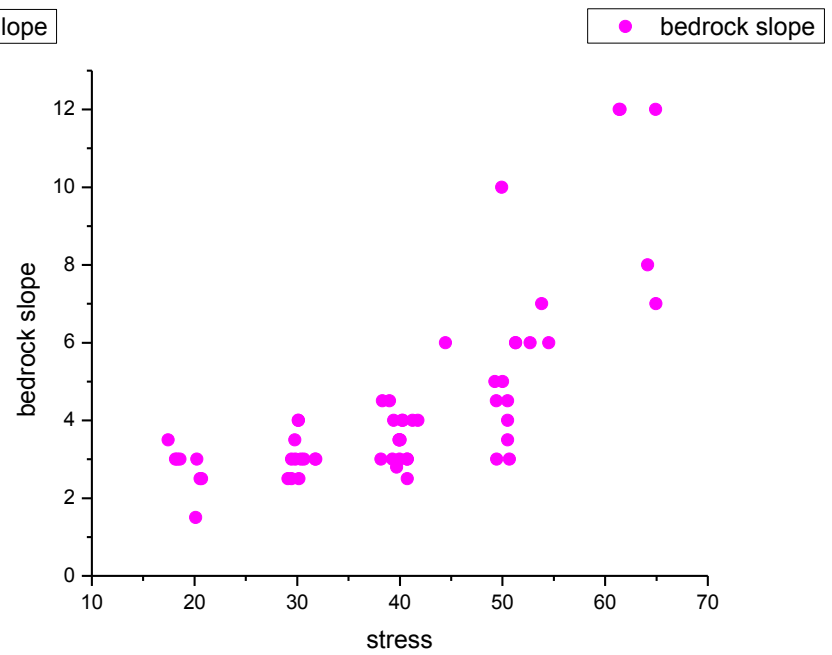
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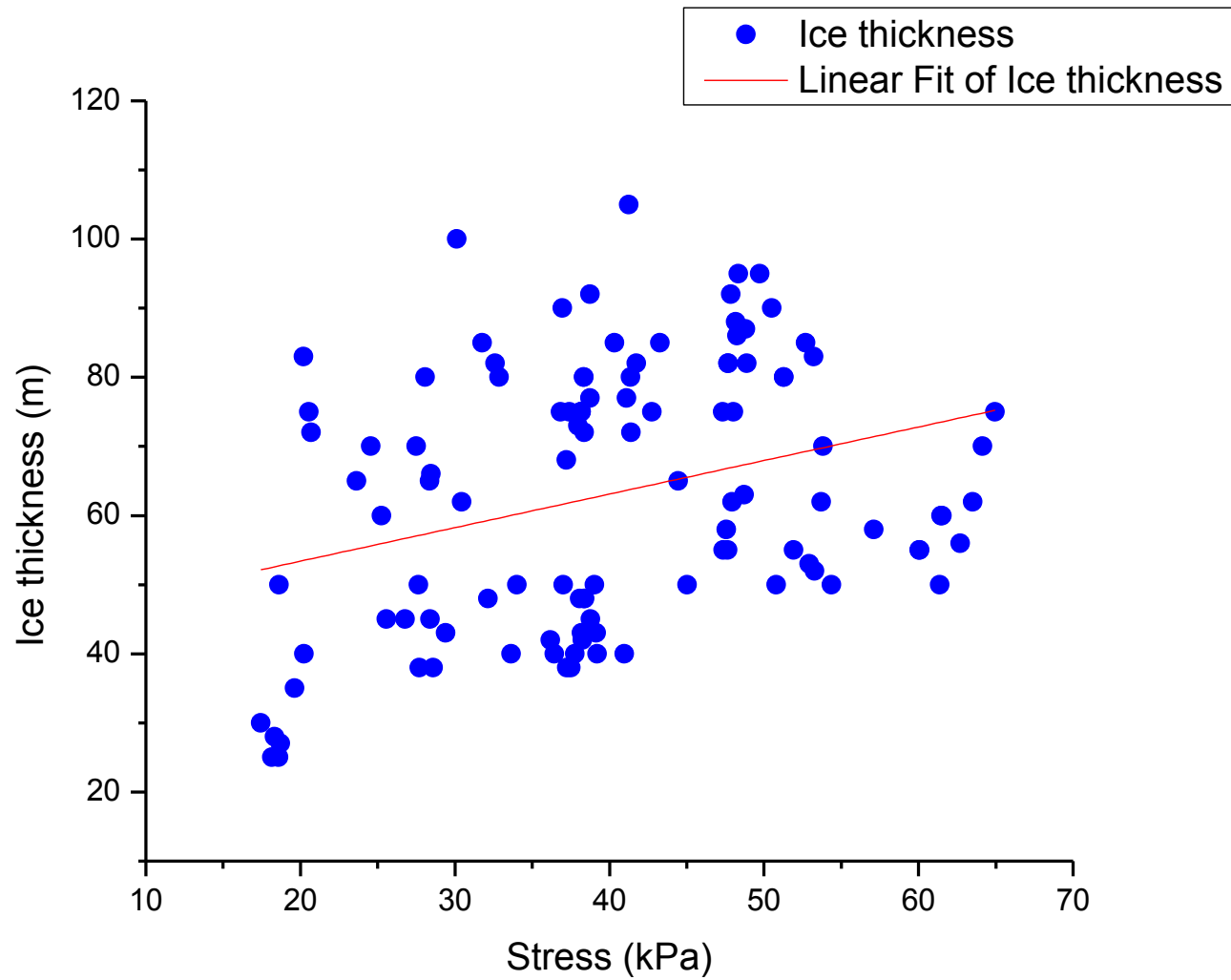


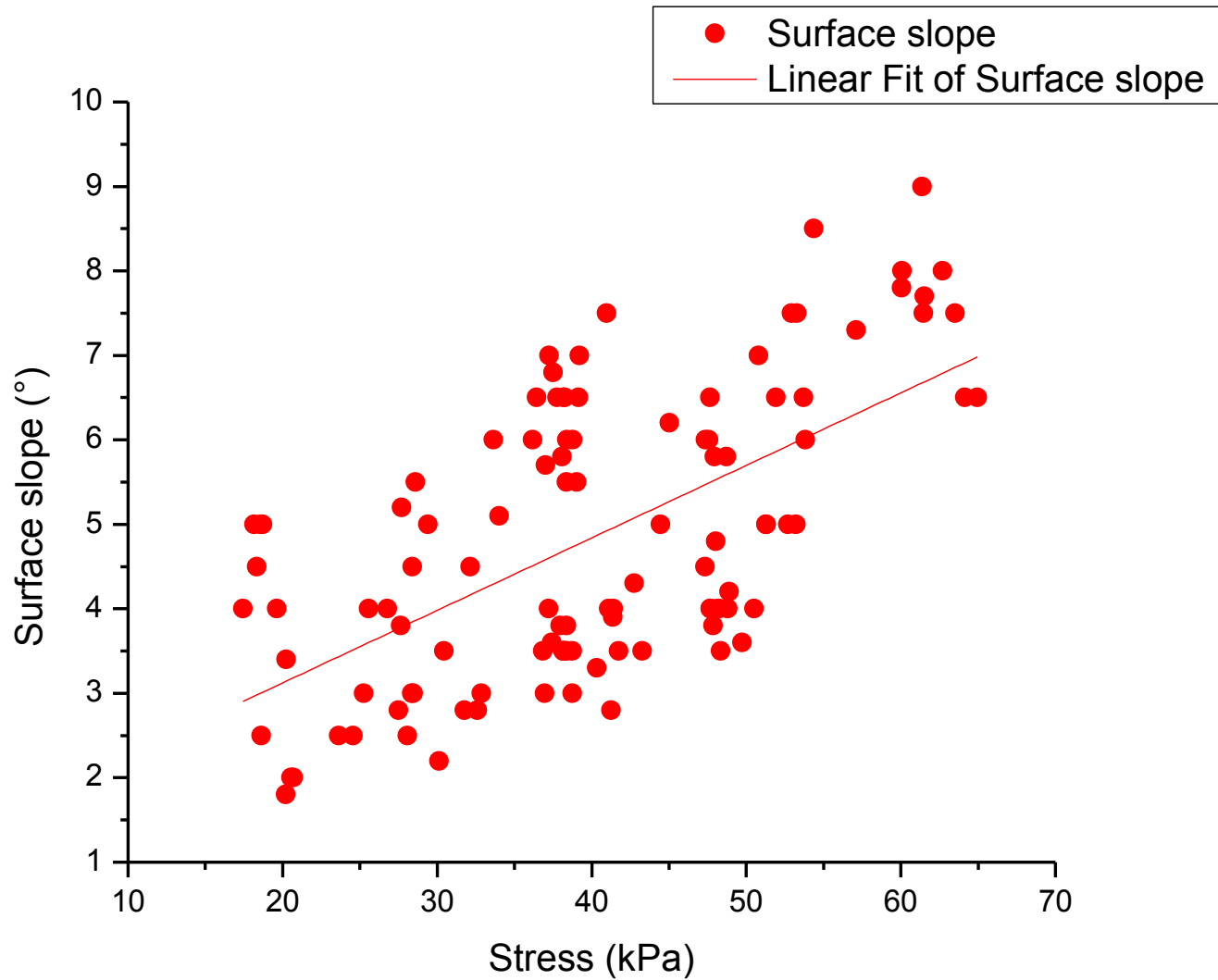
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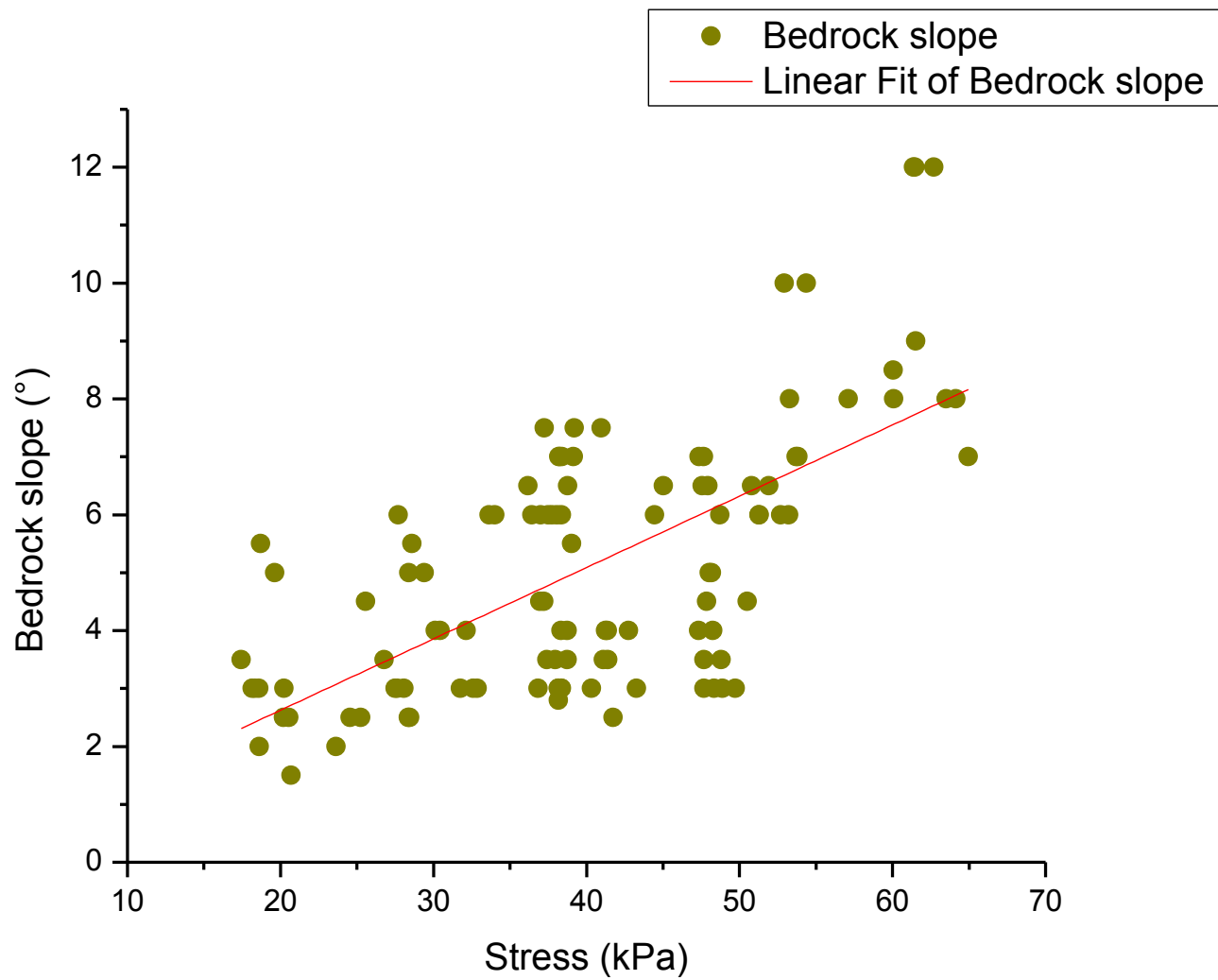


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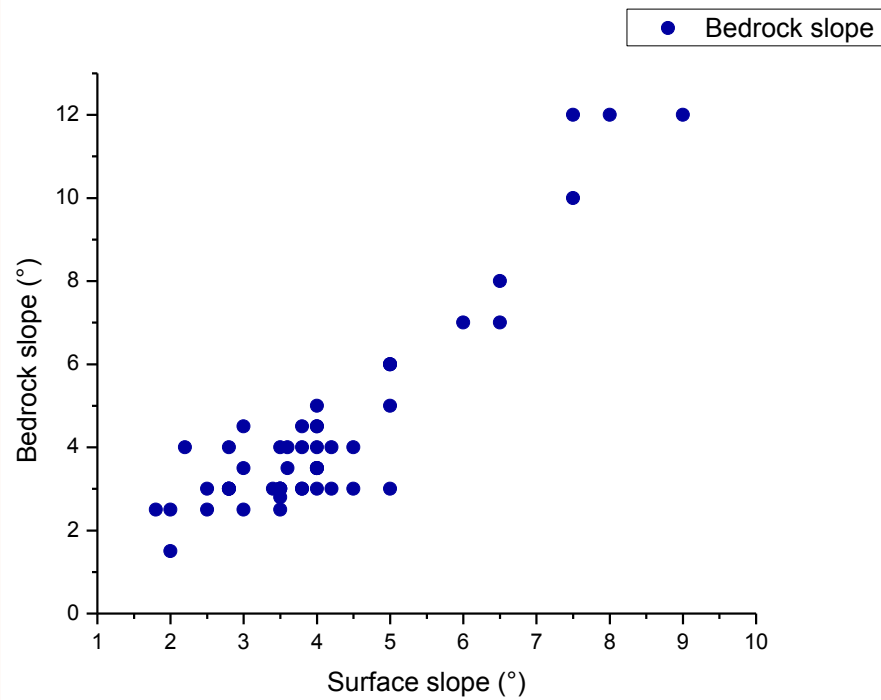




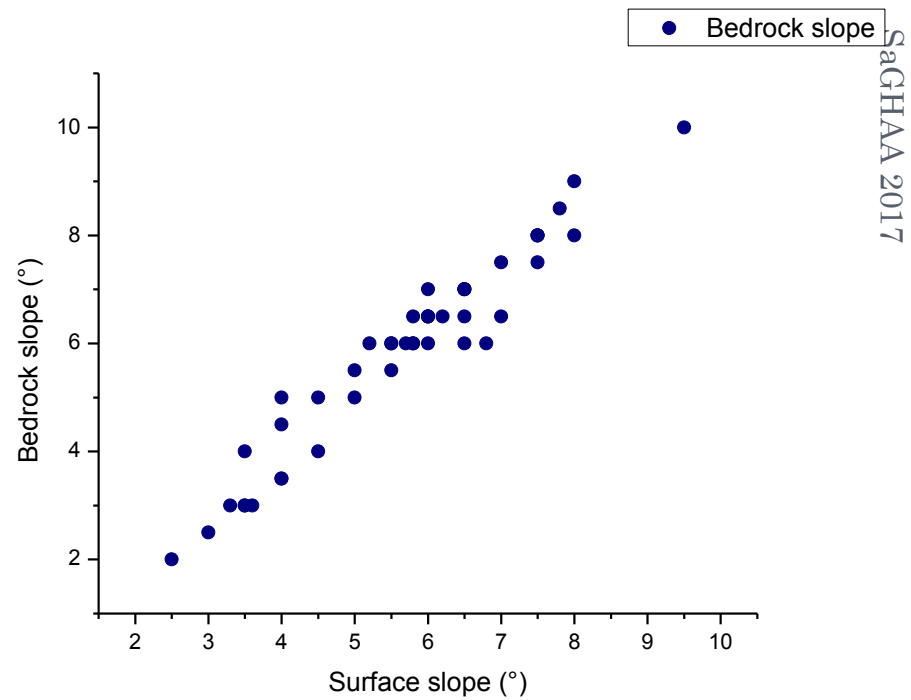


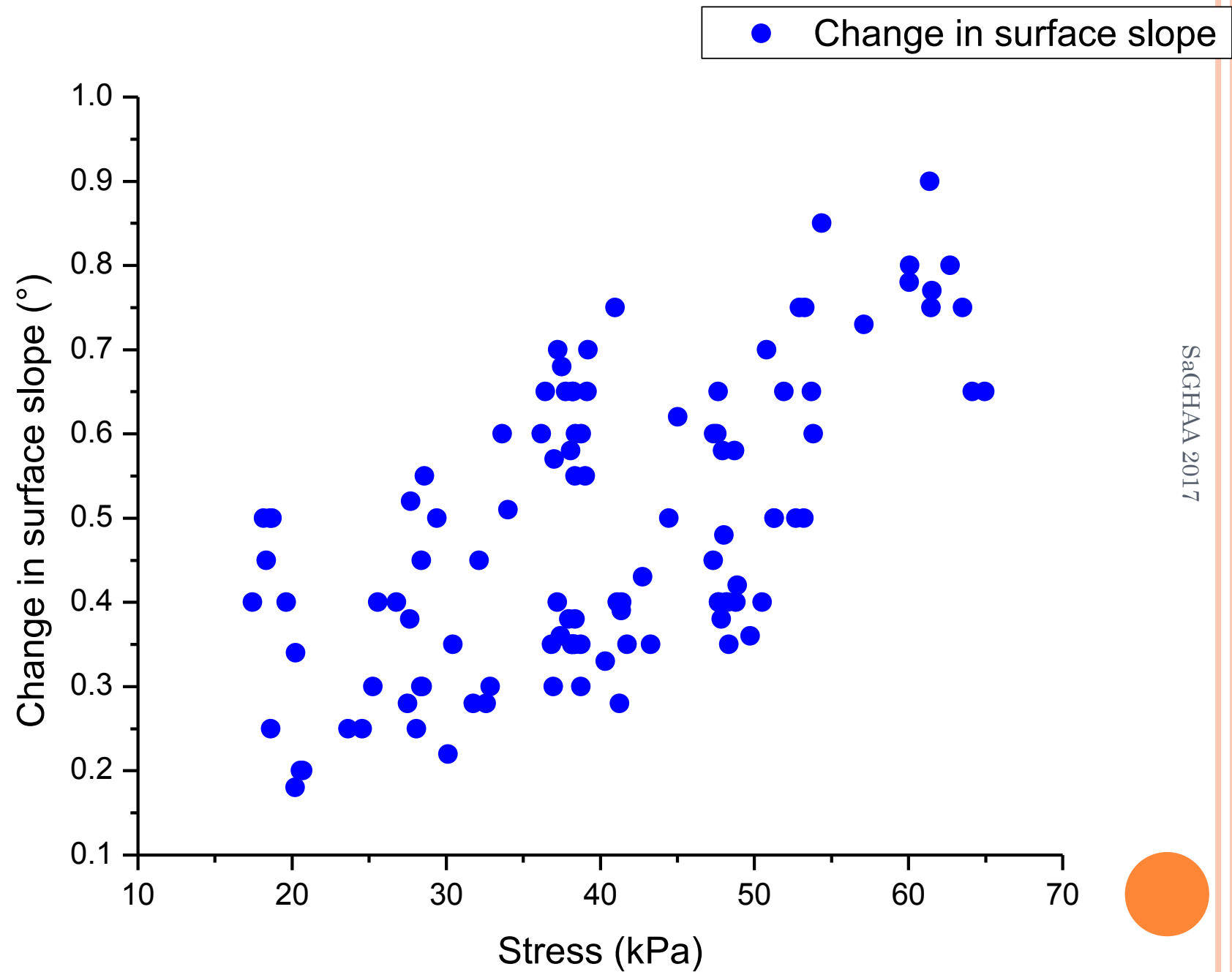


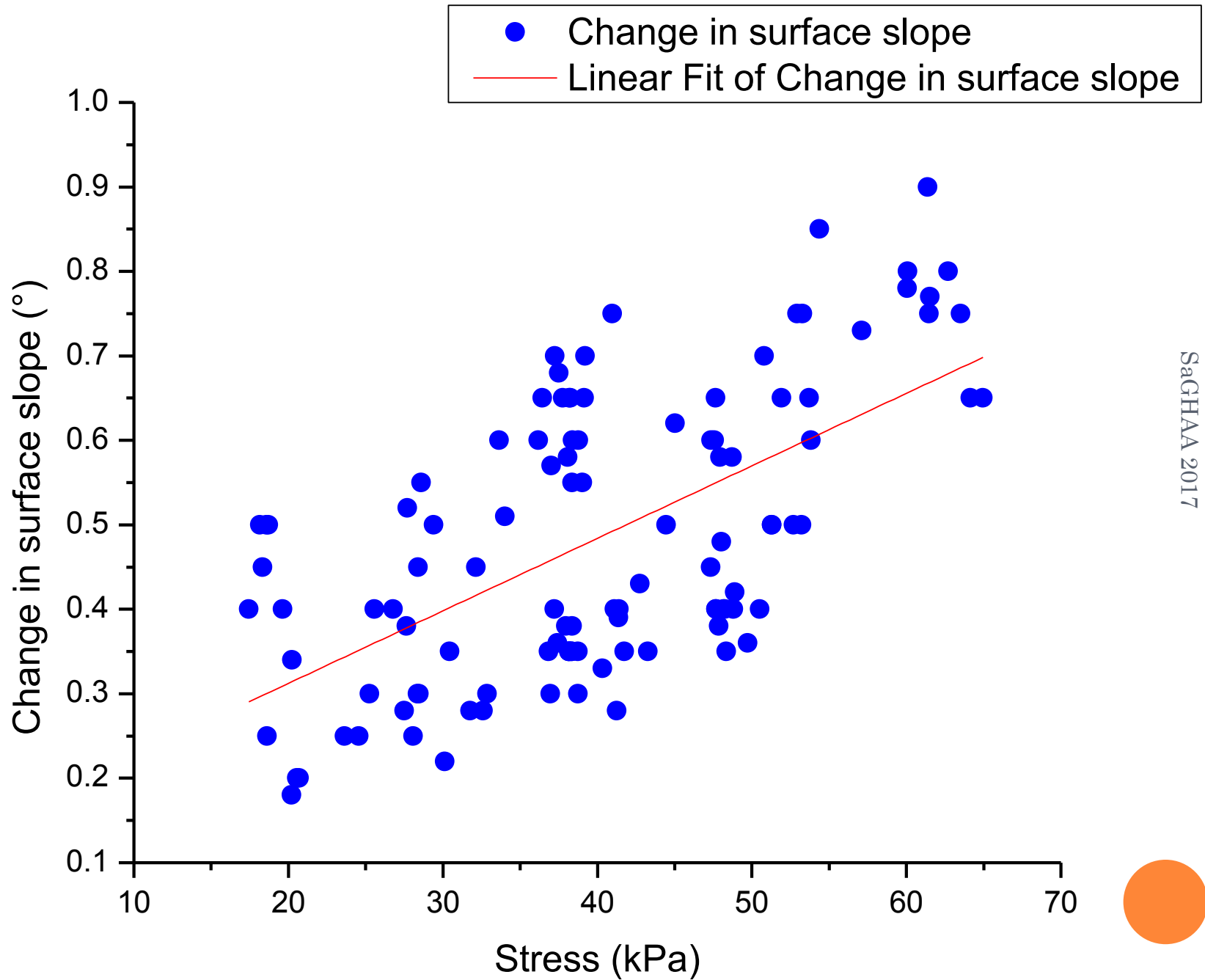
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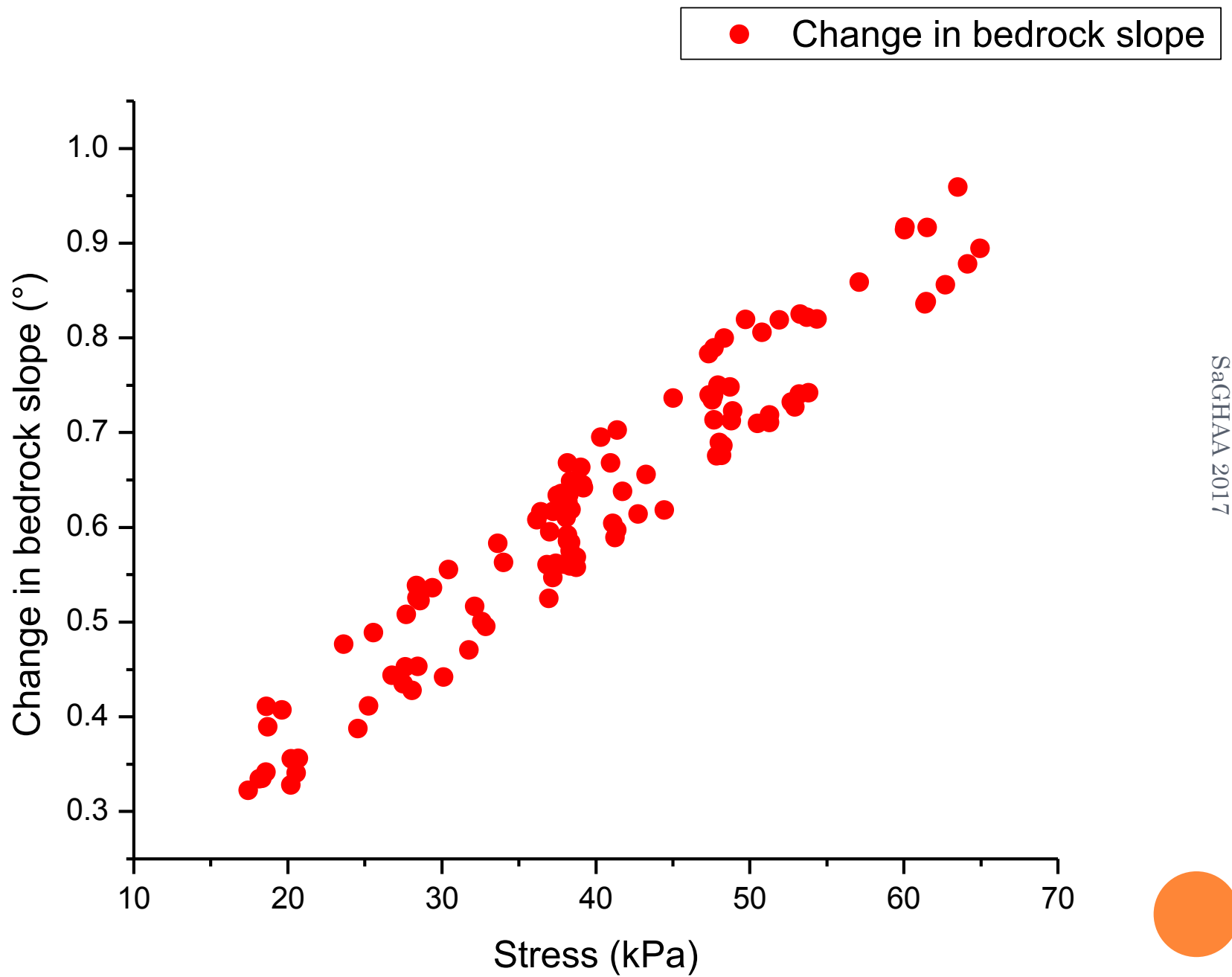


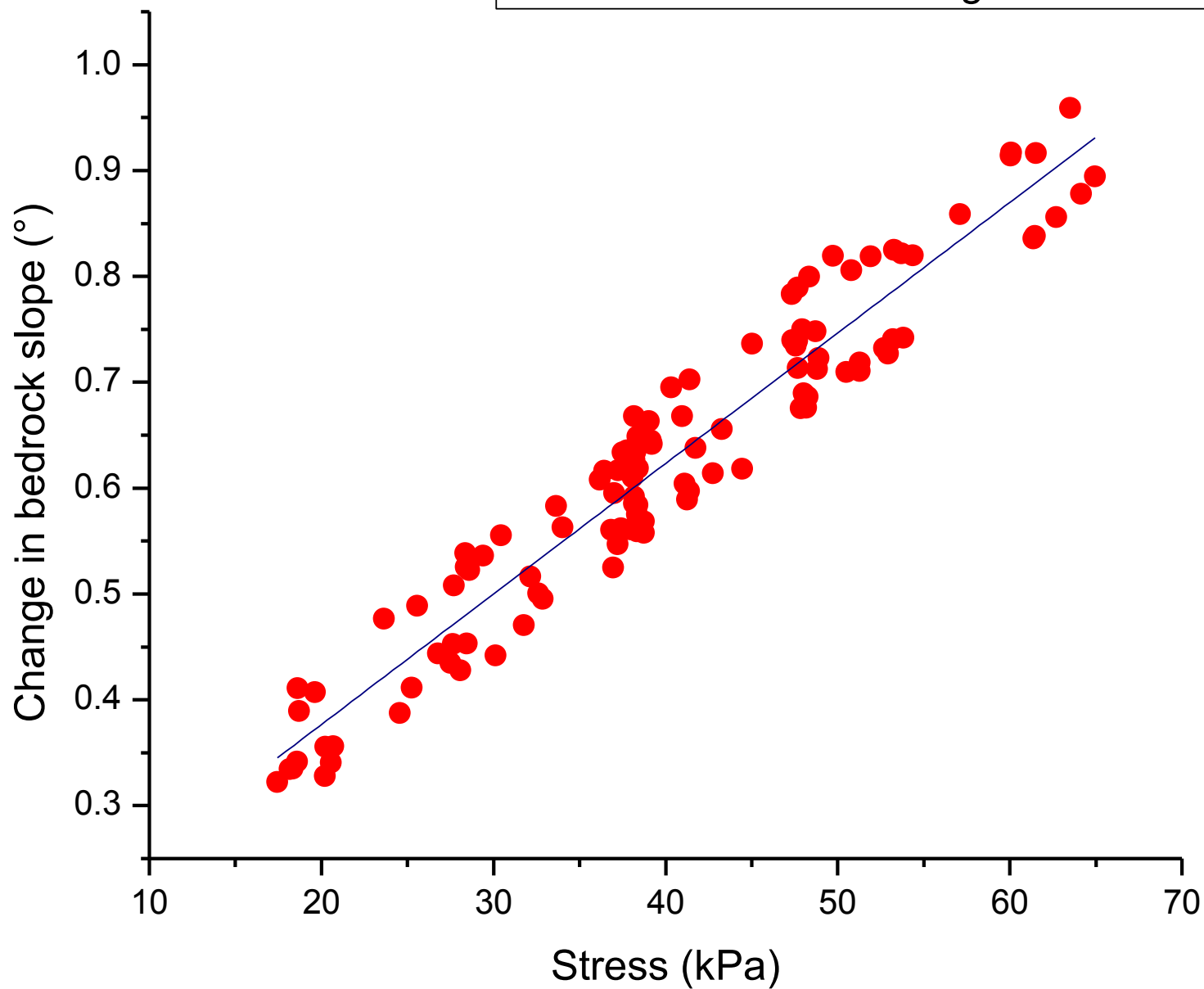
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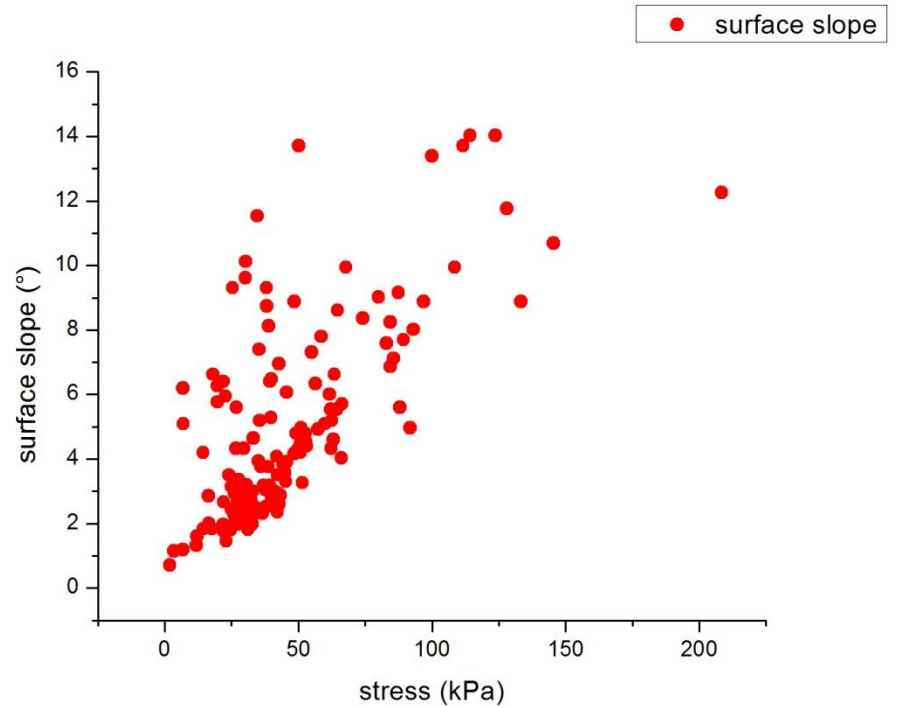
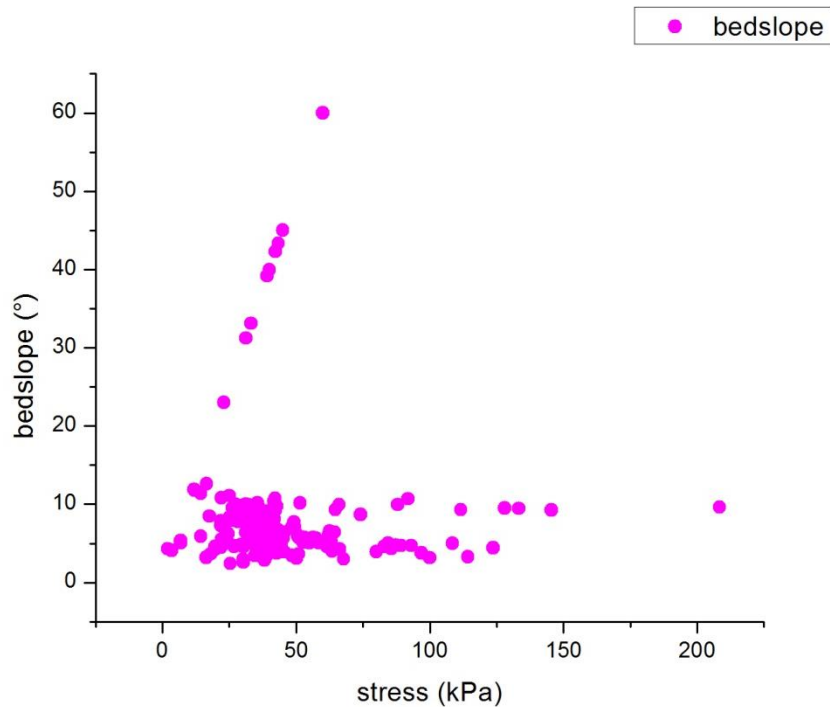
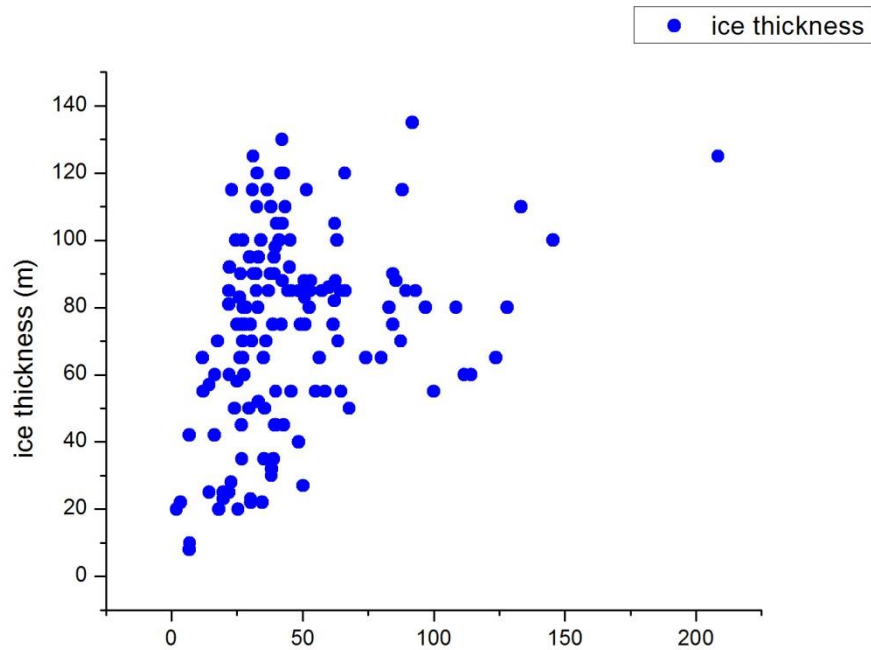




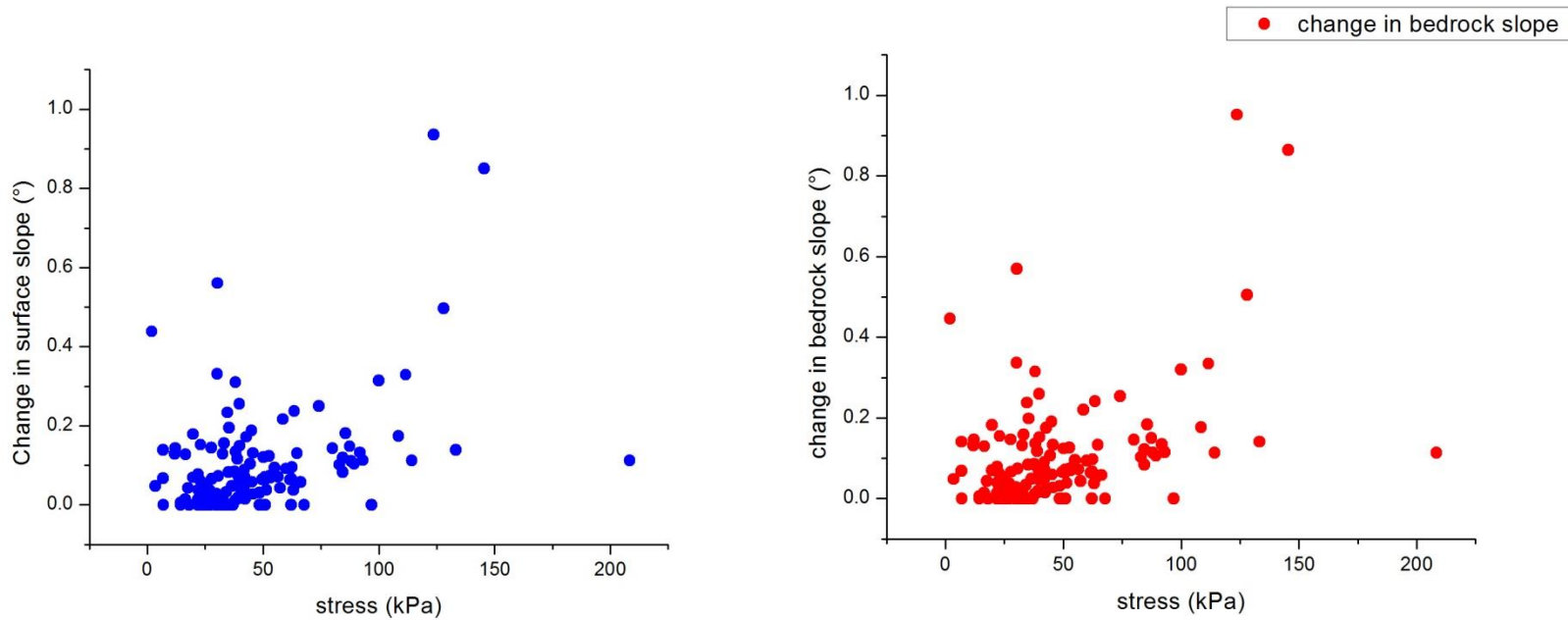




SOUTH OF SCHIRMACHER OASIS, ANTARCTICA



SOUTH OF SCHIRMACHER OASIS, ANTARCTICA





PROGLACIAL LAKE



**ACCUMULATION
ZONE**





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OU