

Kangerlussuaq Airport:

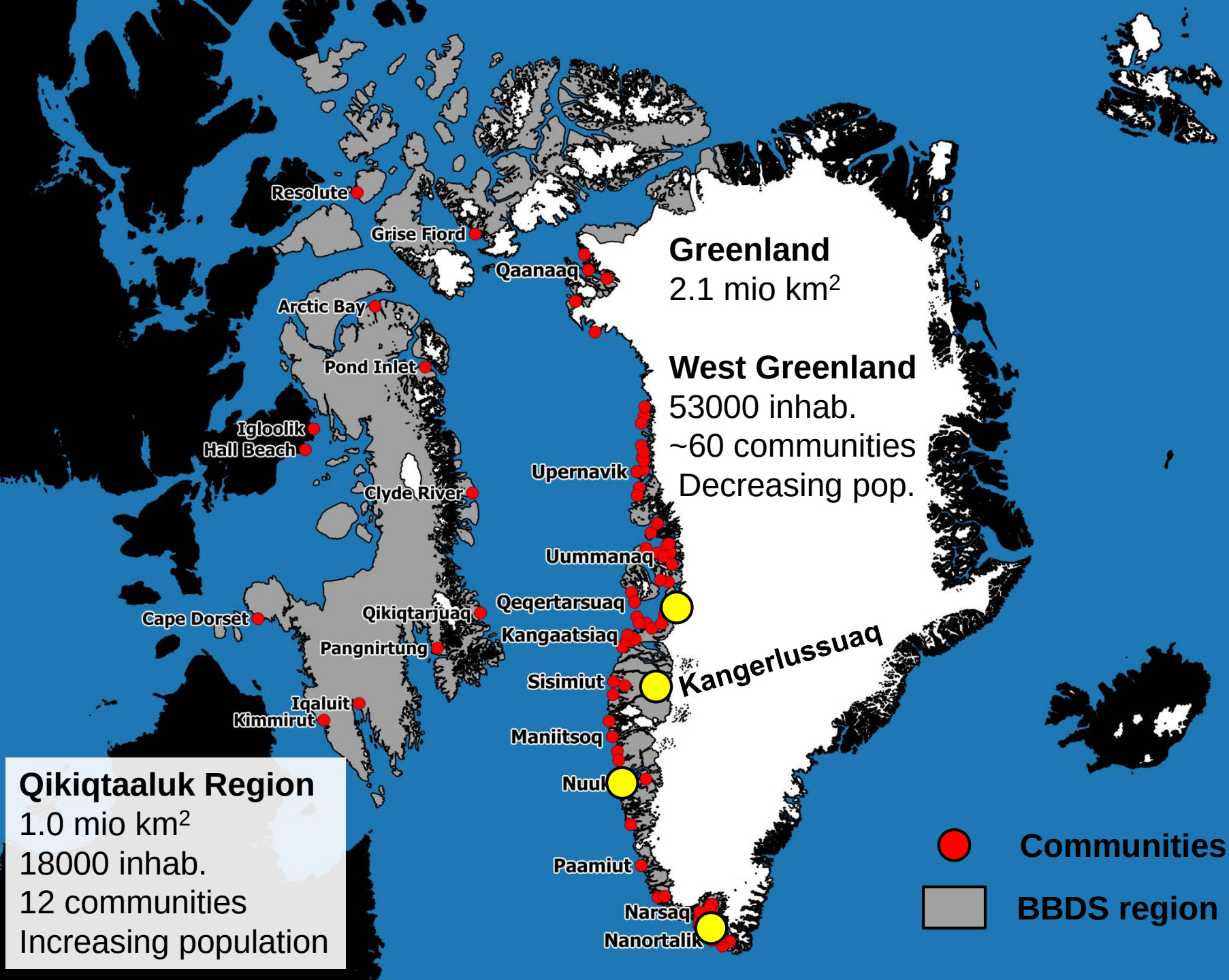
- Establishing a borehole database in support of future operational and maintenance decisions

Thomas Ingeman-Nielsen og Niels Foged
Center for Arktisk Teknologi, DTU

2018-05-03



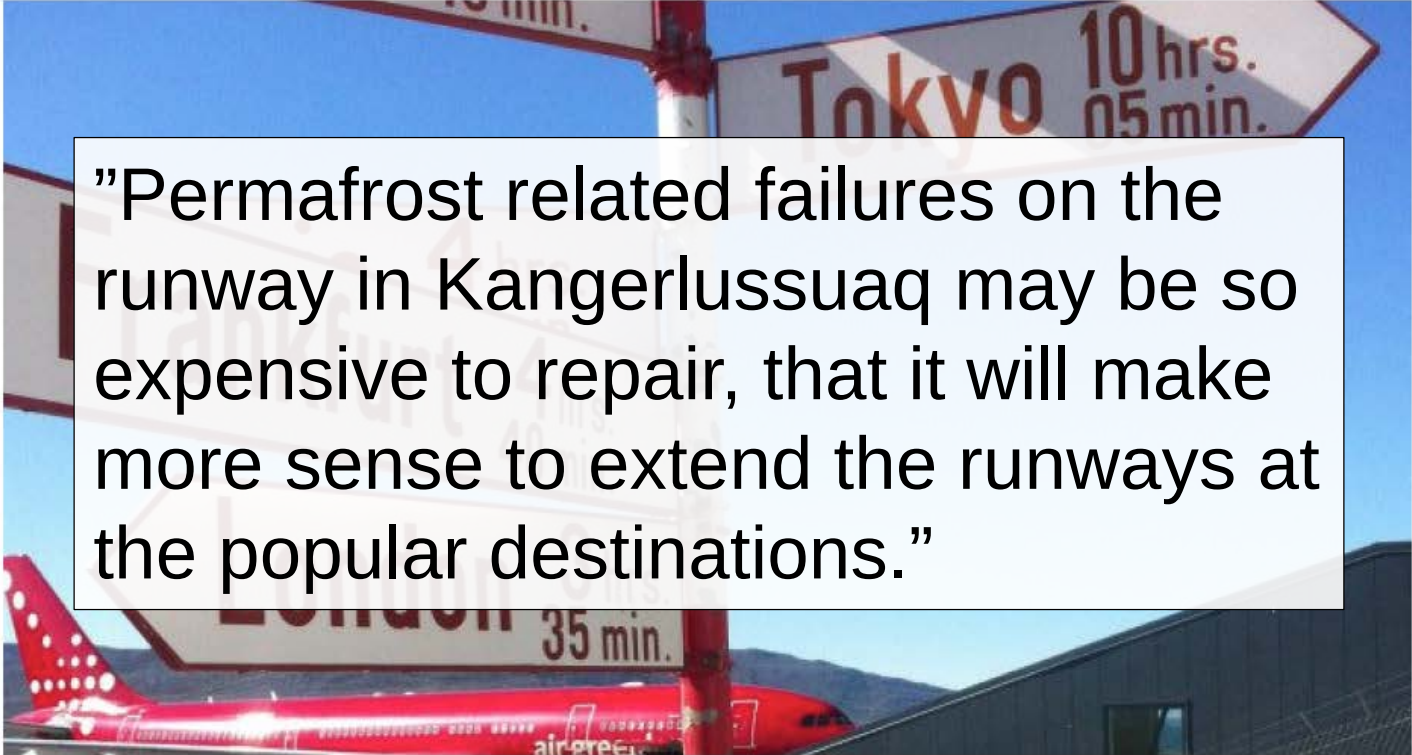
tin@byg.dtu.dk og nf@byg.dtu.dk



INFRASTRUKTUR-DILLEMMMA

Milliardregning forpludrer lufthavnskabale

Permafrostskader på atlantlandingsbanen i Kangerlussuaq kan blive så dyre at rette op på, at det giver bedre mening at udvide lufthavnene på de populære destinationer



"Permafrost related failures on the runway in Kangerlussuaq may be so expensive to repair, that it will make more sense to extend the runways at the popular destinations."



Aerial photo 1936

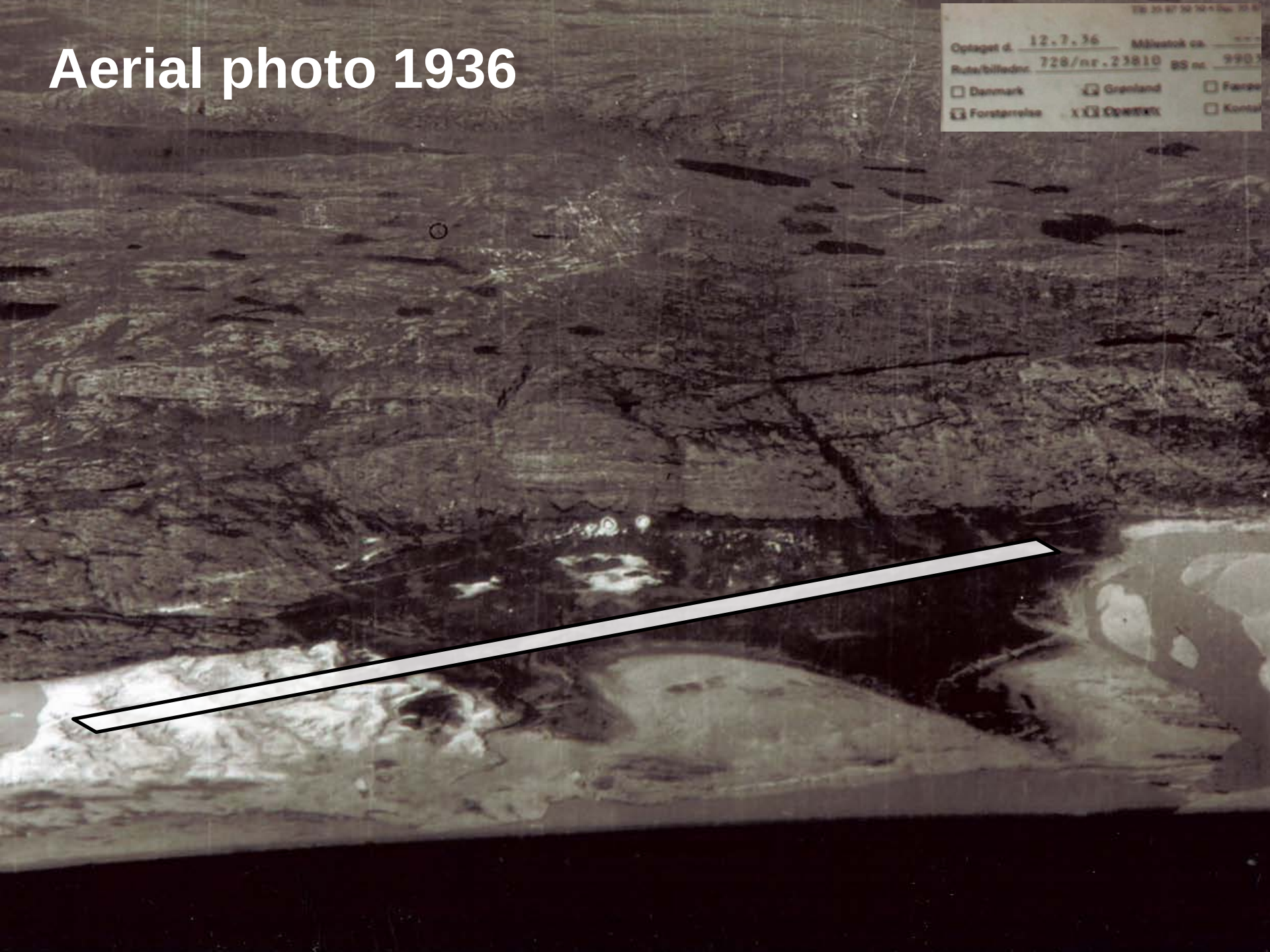
120 35 47 50 52 + 53 54 55

Optaget d. 12. 7. 36 Målestok ca. 1:100 000

Rute/billednr. 728/nr. 23810 BS nr. 9903

☐ Danmark ☒ Grønland ☐ Færøer

☒ Forstørrelse ☒ COPIERET ☐ Kontar

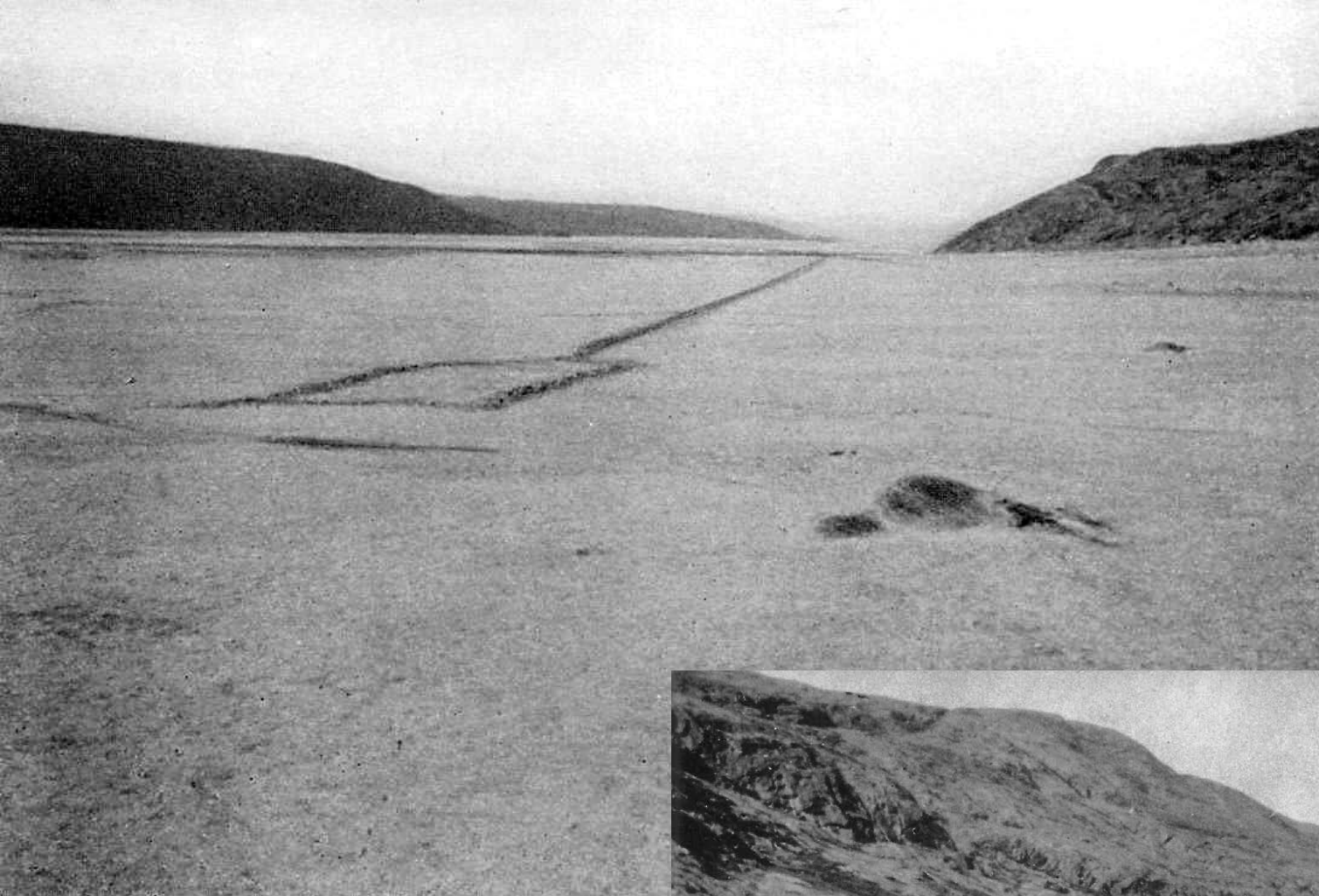




**Bert Hassell and Parker Cramer predicts "Great Circle Route"
as the best alternative for commercial transatlantic air traffic.**

1928 attempt in this Stinson-Detrouer Monoplane

<http://thewildgeese.irish/profiles/blogs/bert-hassell-and-parker-cranmer>

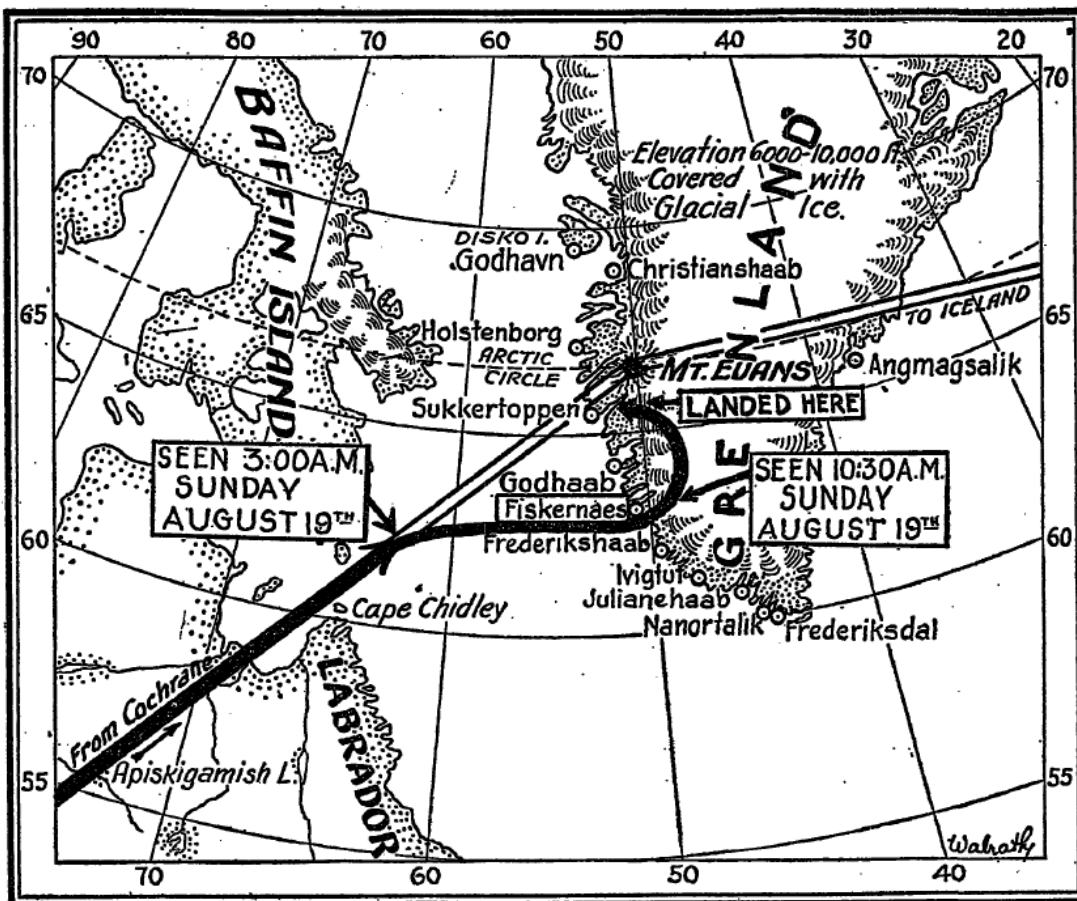


The landing strip in 1928
prepared by Hobbs.



New York Times, 1928

HASSELL AND CRAMER RESCUED IN GREENLAND; FLIERS WANDERED TWO WEEKS OVER ICY WASTES; SMOKE SIGNALS SEEN, SAVED BY HOBBS EXPEDITION



WHERE THE RESCUED FLIERS CAME DOWN.

Map Shows the Route Traveled by the Plane Greater Rockford Till Its Descent Two Weeks Ago Yesterday on

LIVED ON 8 OUNCES OF PEMMIGAN A DAY

Eskimos Gave Clue--Rescuers Sent Two Boats After Castaways--Flashlight Signaled "Hassell Safe" to Camp.

LANDED THE PLANE UNDAMAGED ON AUGUST 19

Driven Off Course by Storm and Running Out of Gasoline, They Were Forced Down on Sukkertoppen Ice Arm After Being Sighted.

By PROFESSOR W. H. HOBBS,

Leader of the University of Michigan Greenland Expedition.

Copyright, 1928, by The New York Times Company.
Wireless to THE NEW YORK TIMES.

MOUNT EVANS, Greenland, Sept. 2.—Bert Hassell, pilot of the plane Greater Rockford, and his co-pilot, Parker Cramer, missing for two weeks after they had started on the second leg of their flight from Rockford, Ill., for Stockholm, Sweden, are in Camp Lloyd, safe and well.

They arrived in our motor boat at 9:15 P. M. (Greenland Time) after we had found them on the south side of the fjord in

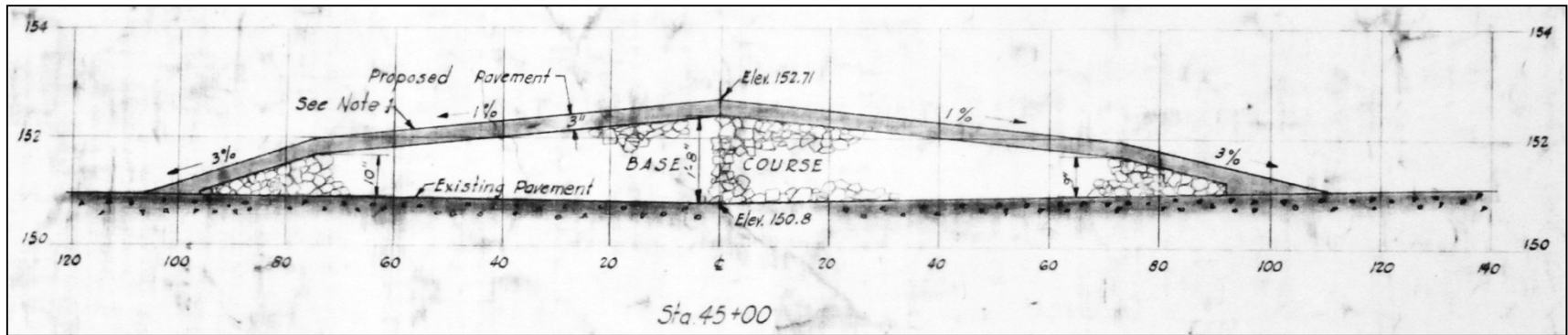
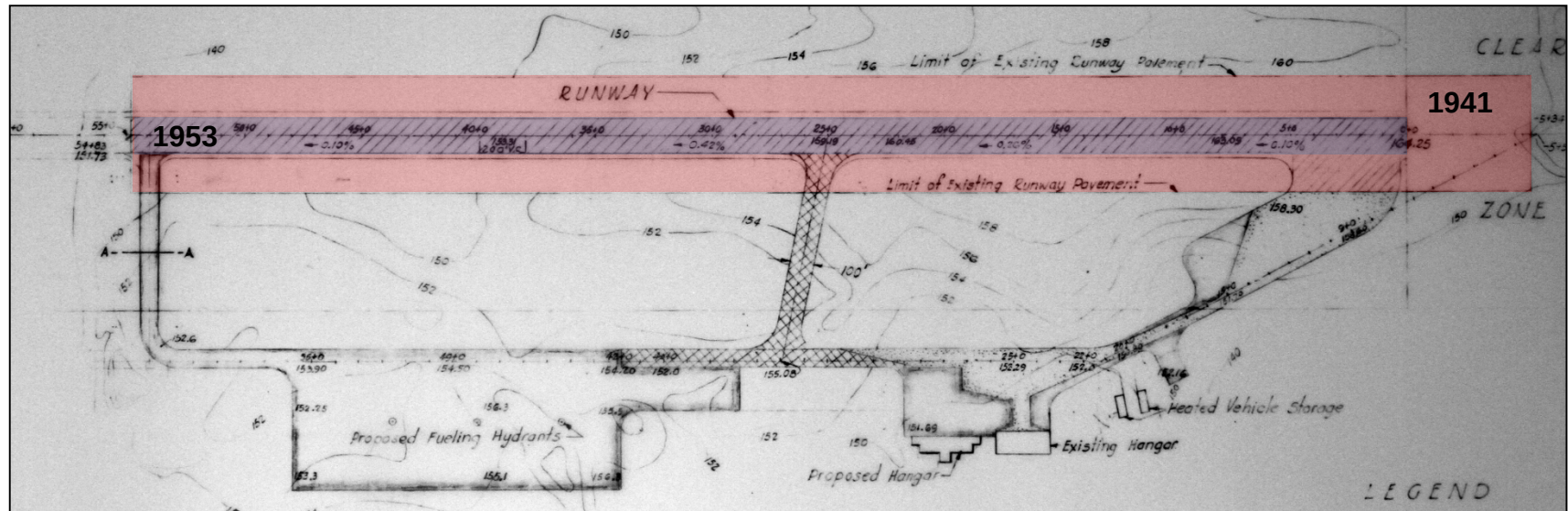
1941-1942

First airstrip

ca. 1840 m x 140 m

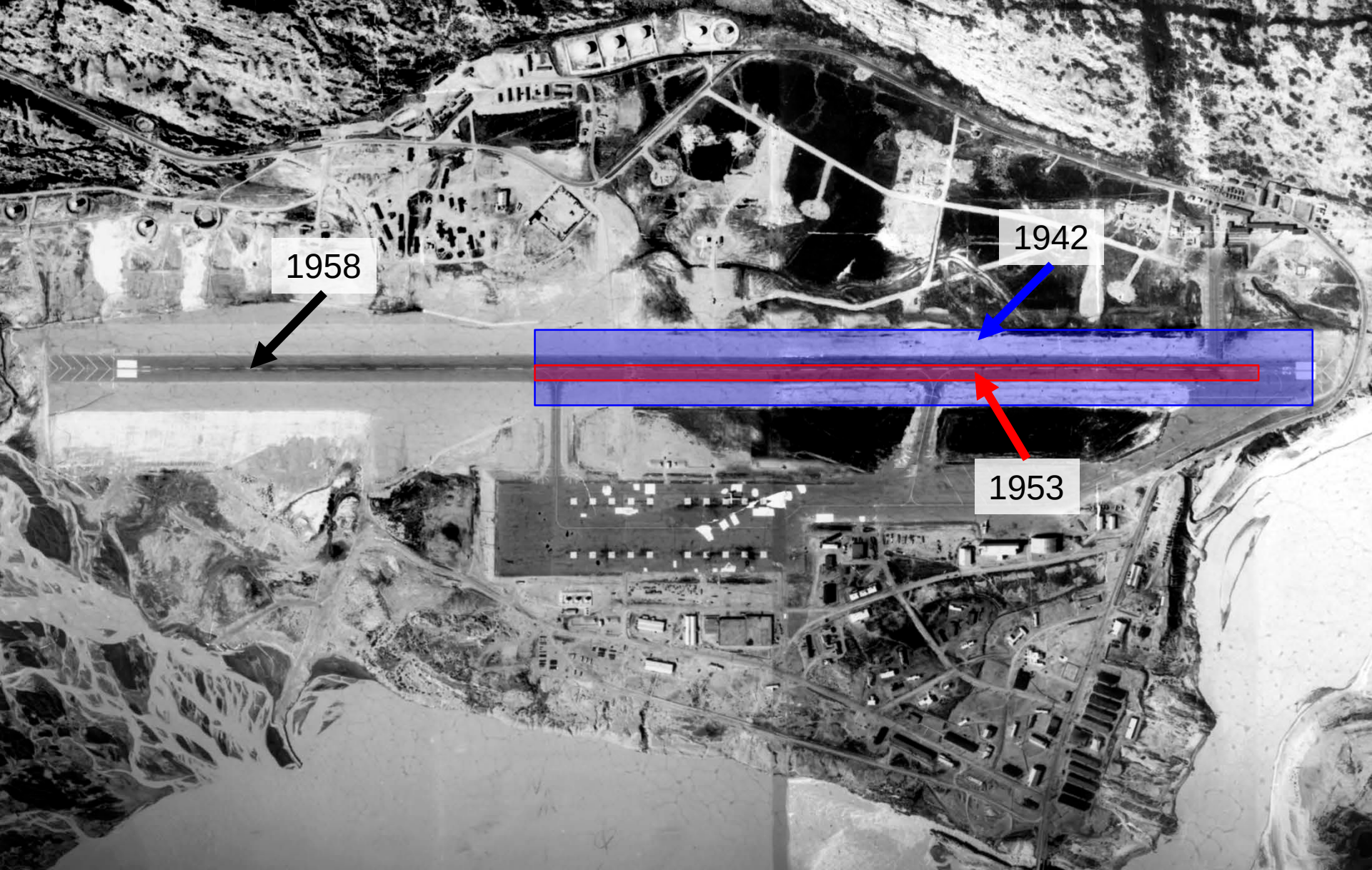


Runway strengthening - 1953



ca. 1700 m x 46 m

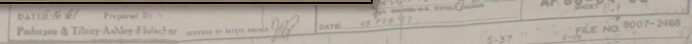
Kangerlussuaq 1967

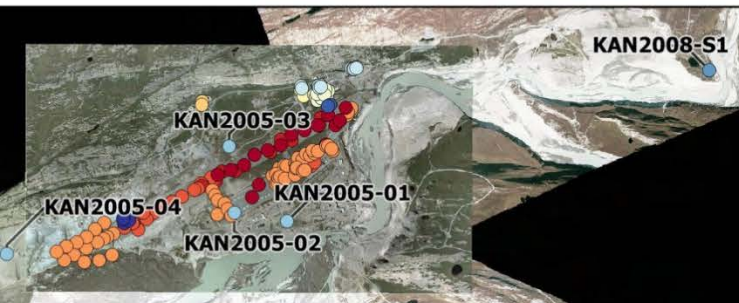


1958

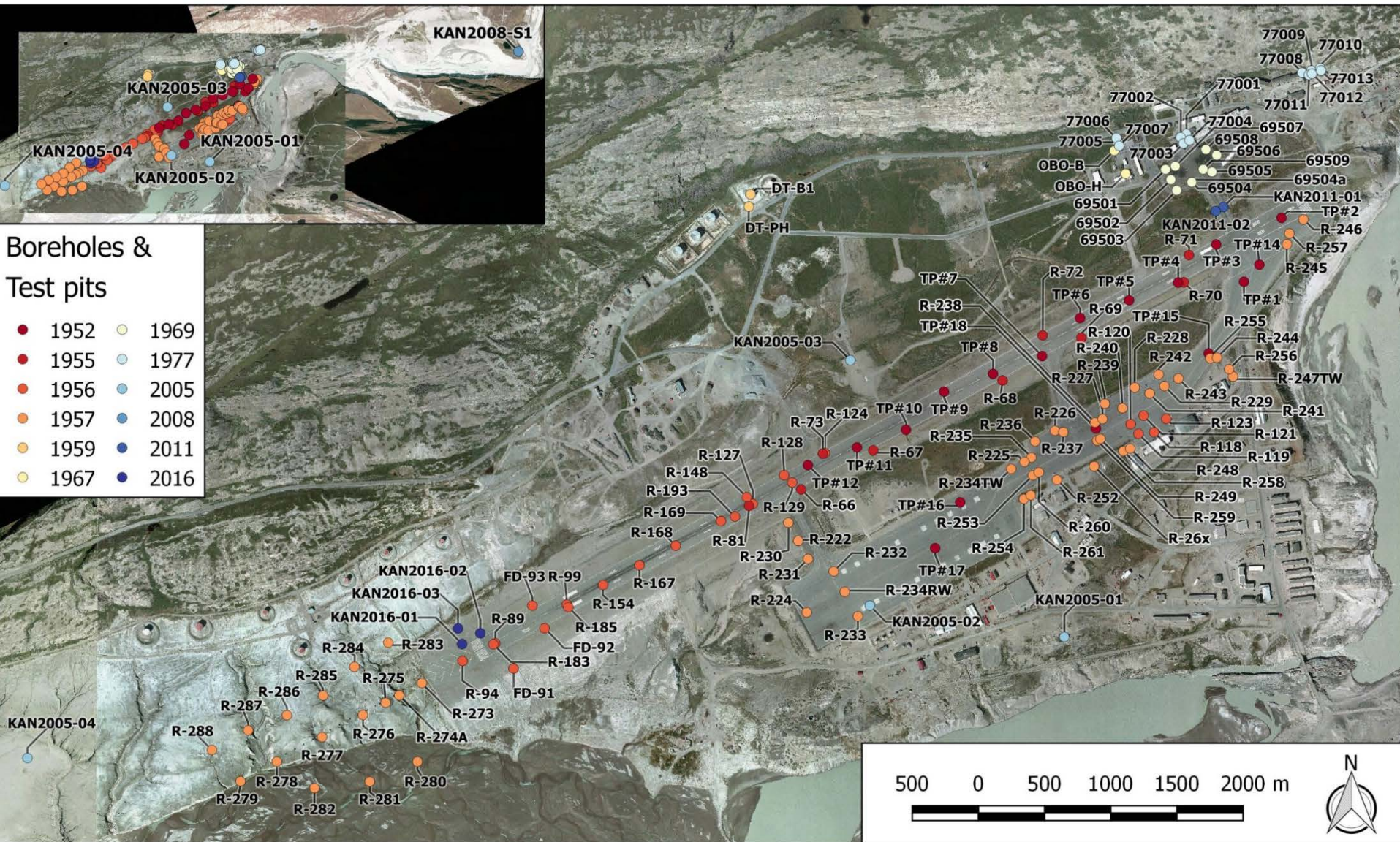
1942

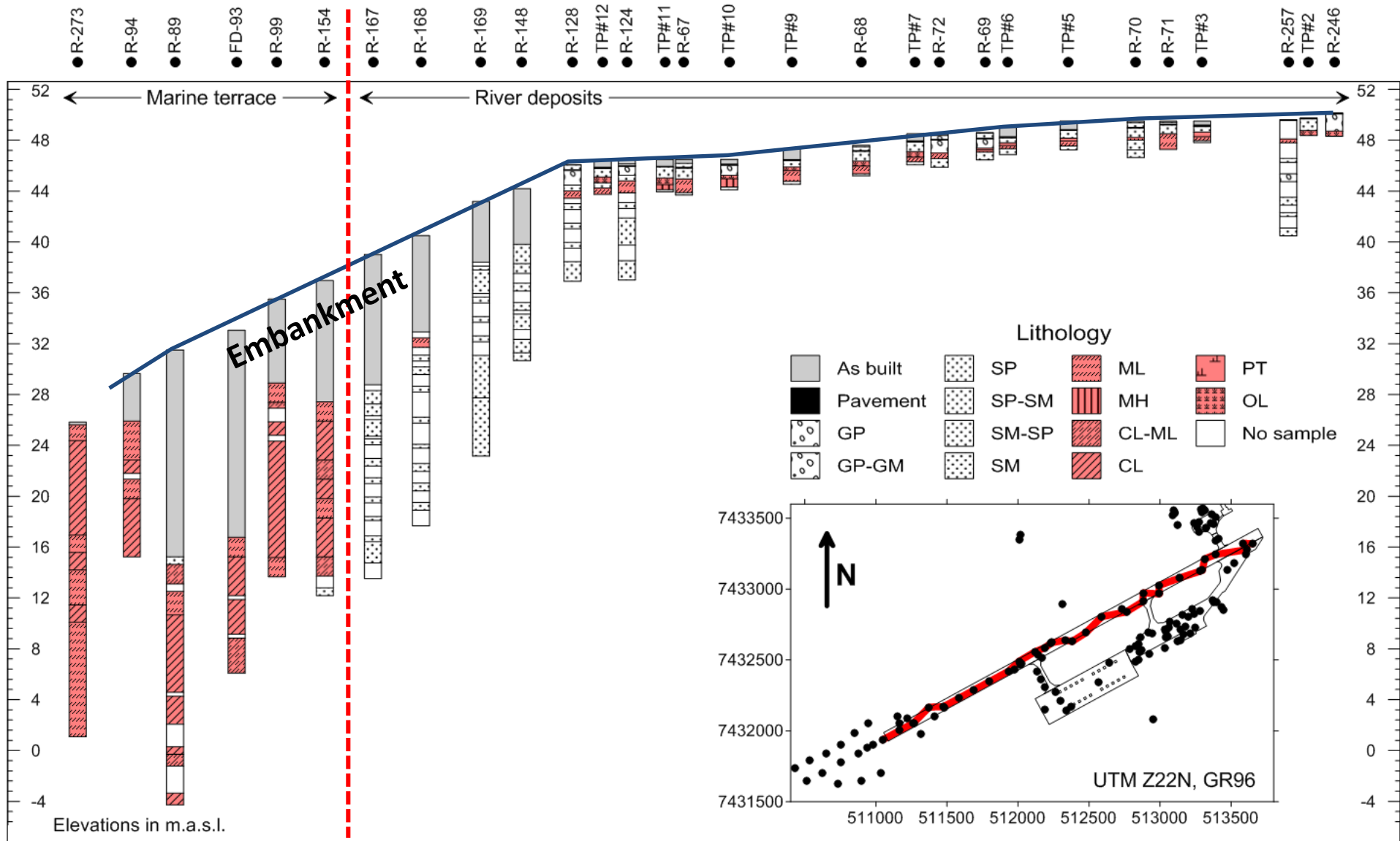
1953





Boreholes & Test pits





A total of 147 boreholes, with 42 holes along runway

- 11 boreholes on **marine terrace**
- OPMC fines = $61.8\% \pm 12.5\%$ (n=63)
- Encountered: IX, II, IS, unfrozen

Conclusions:

- Ice rich and thaw sensitive
- Protected by thick embankment
- Frost susceptible material?
- Heat trapped under construction?

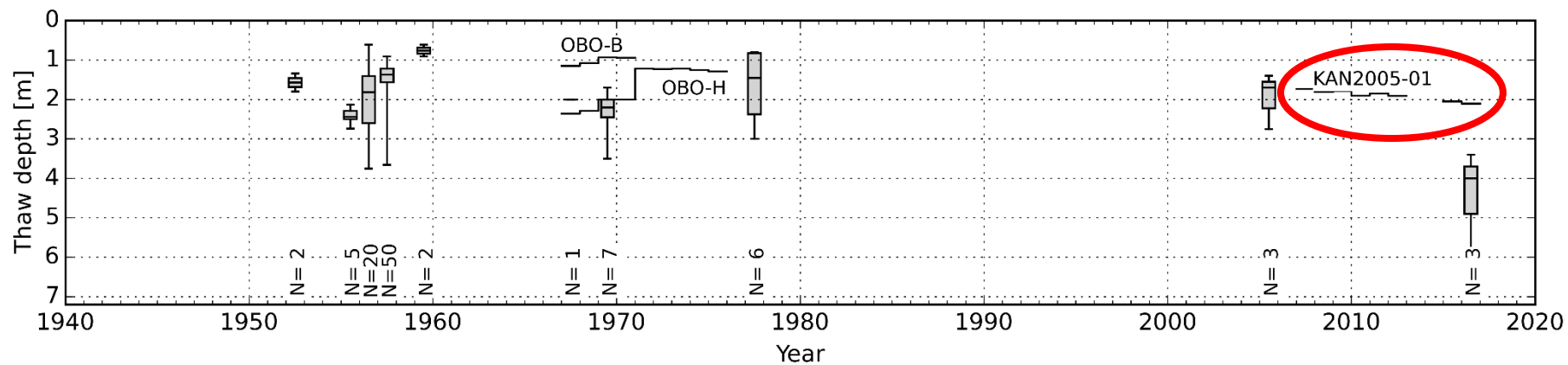
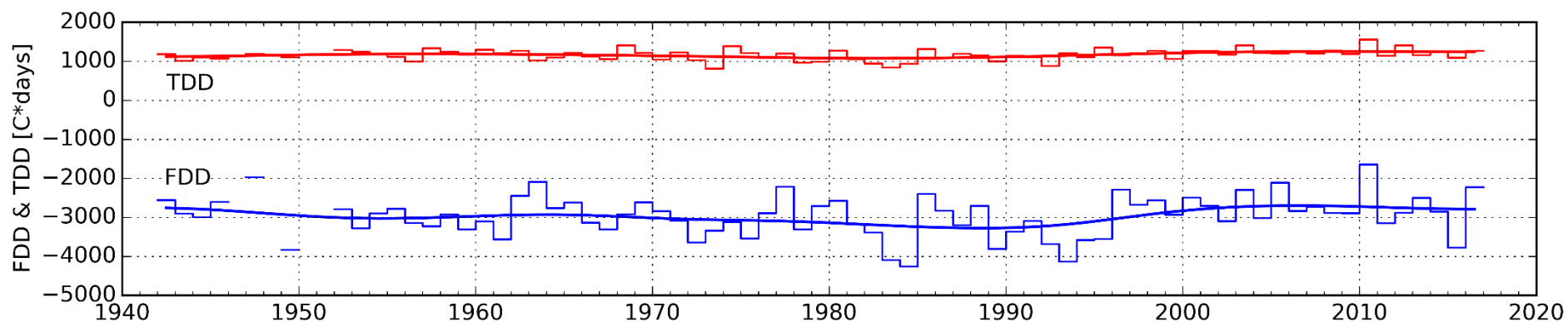
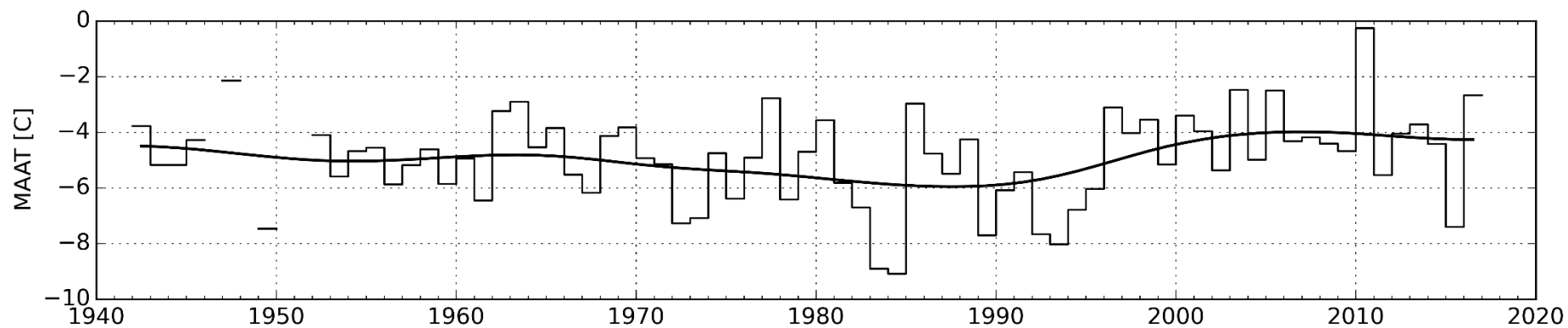


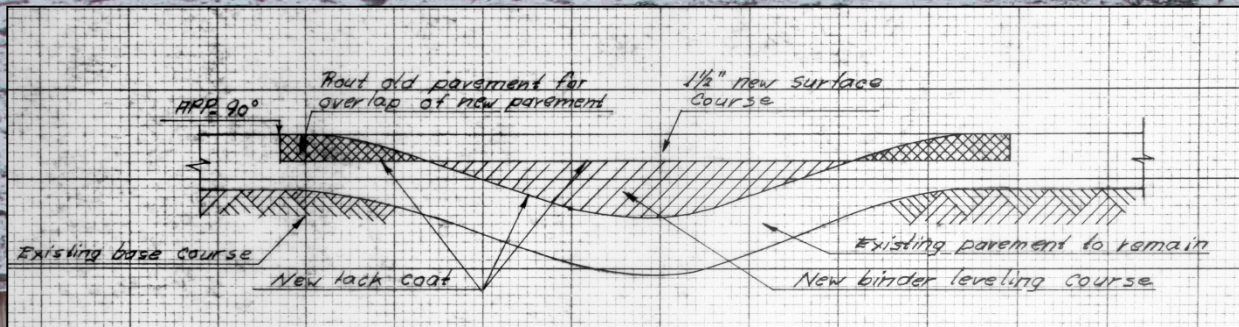
- 31 boreholes on **river plateau**
- OPMC median 0.7 m, max 1.4 m
- All but 7 bh penetrate OPMC layers
- OPMC fines = $17.5\% \pm 9.0\%$ (N=38)
- SM-SP fines = $4.7\% \pm 3.5\%$ (N=64)
- Encountered: Np and Nw

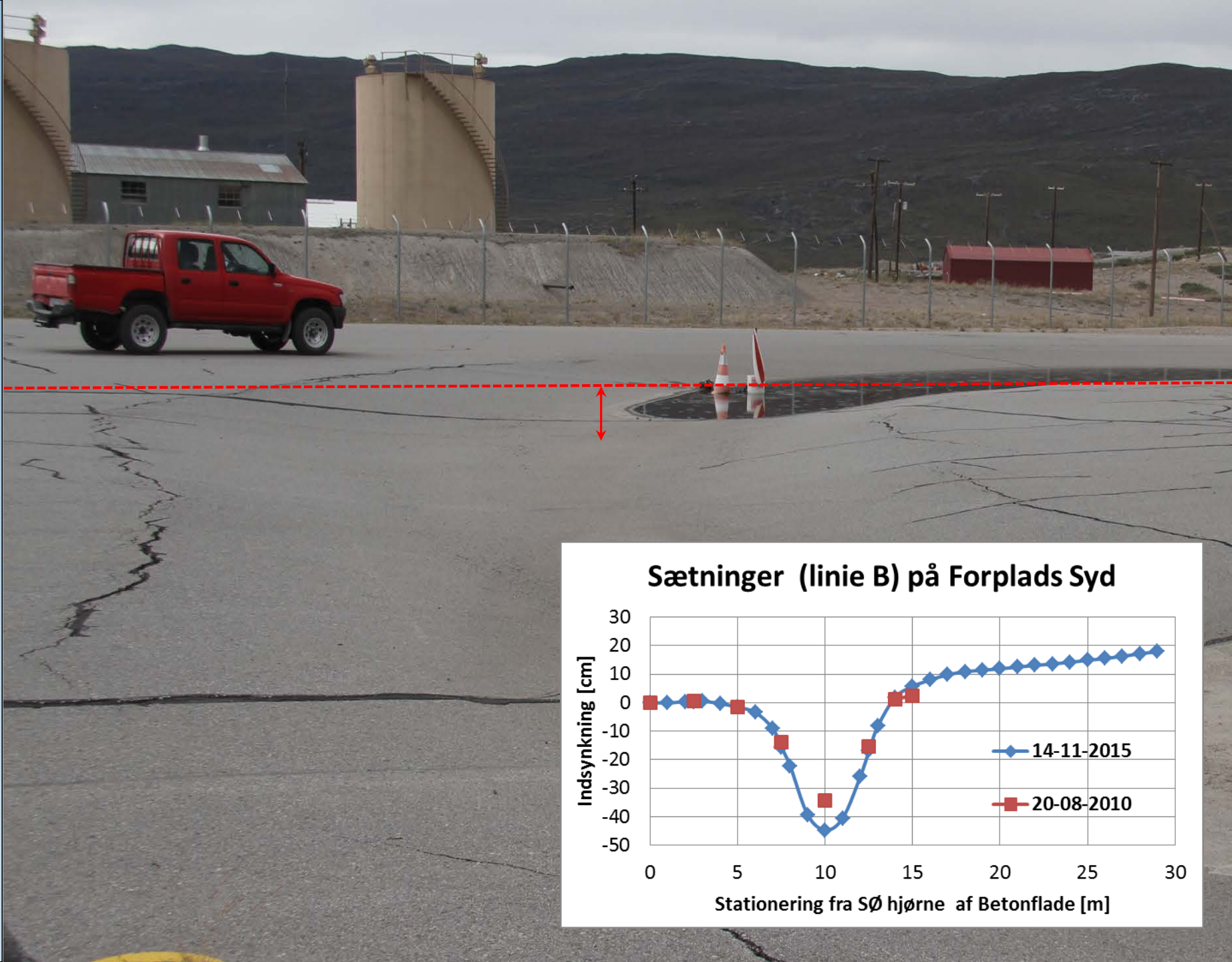
Conclusions:

- OPMC layers included in AL
- OPMC layers of limited thickness
- Ice poor sediments below
- Thaw settlement potential = LOW!

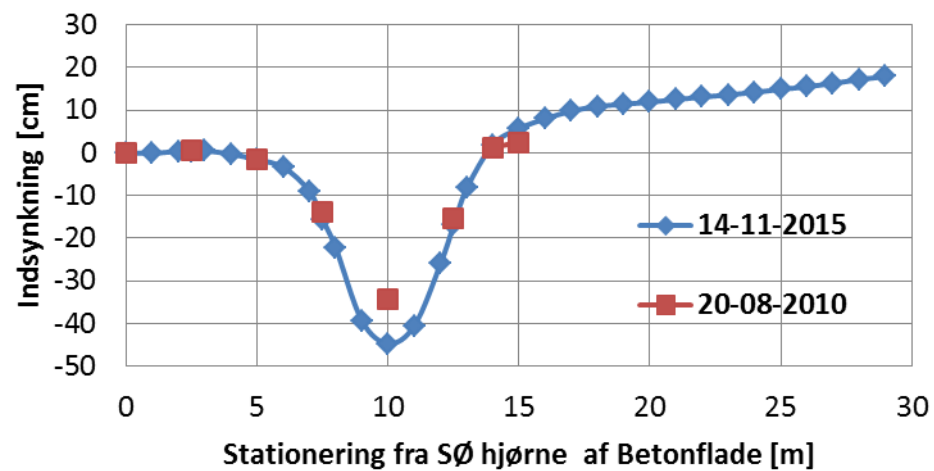


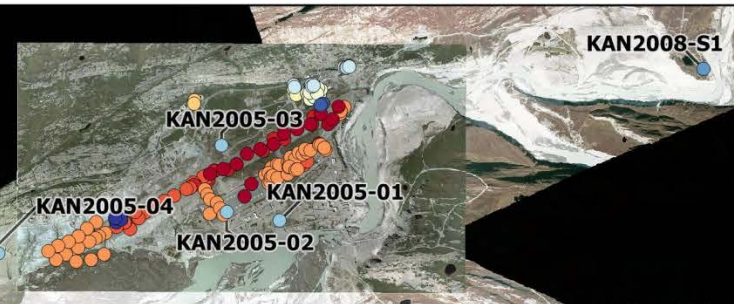




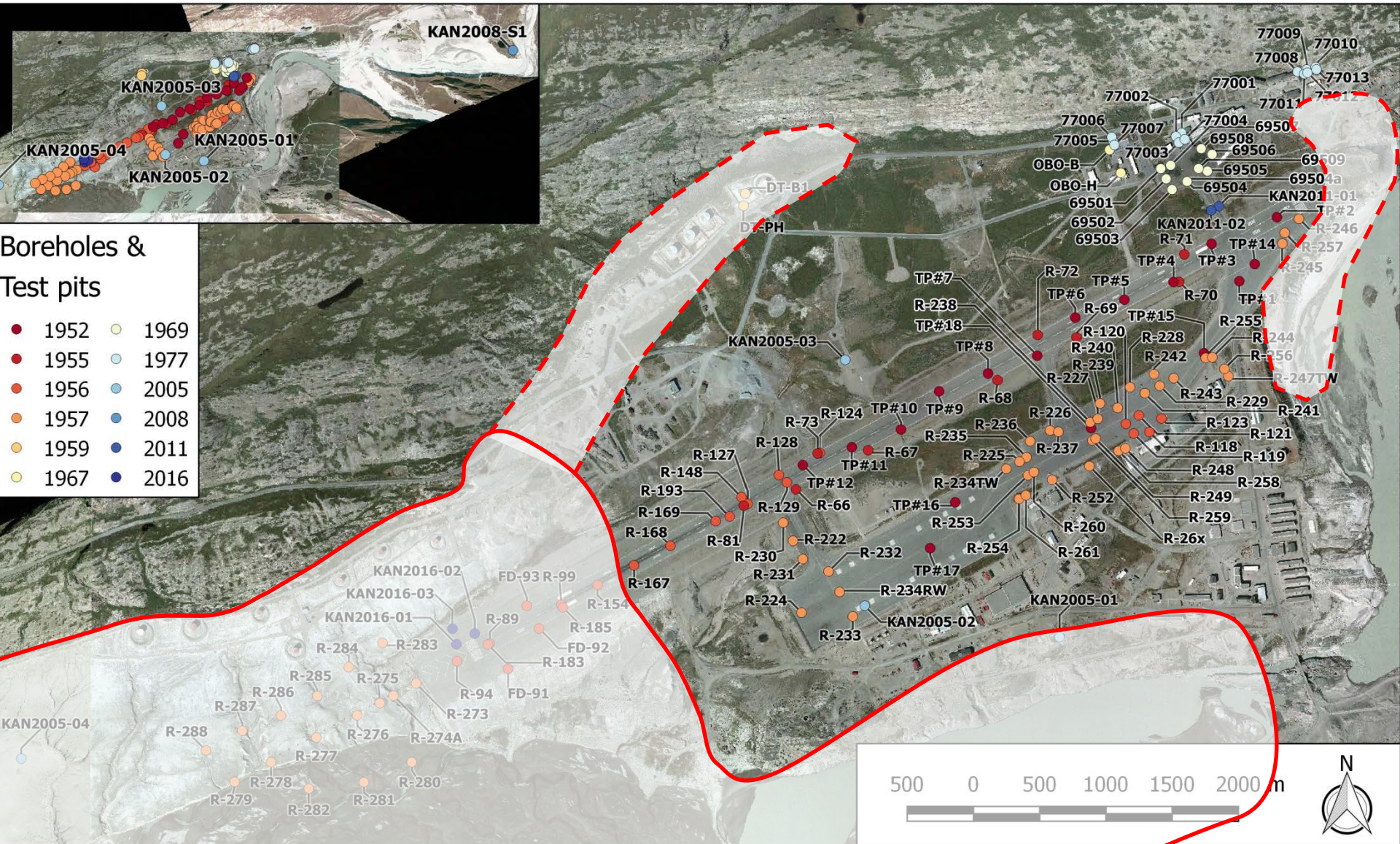
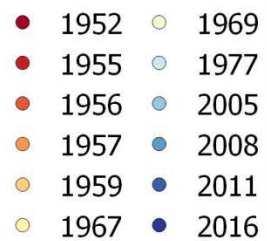


Sætninger (linie B) på Forplads Syd

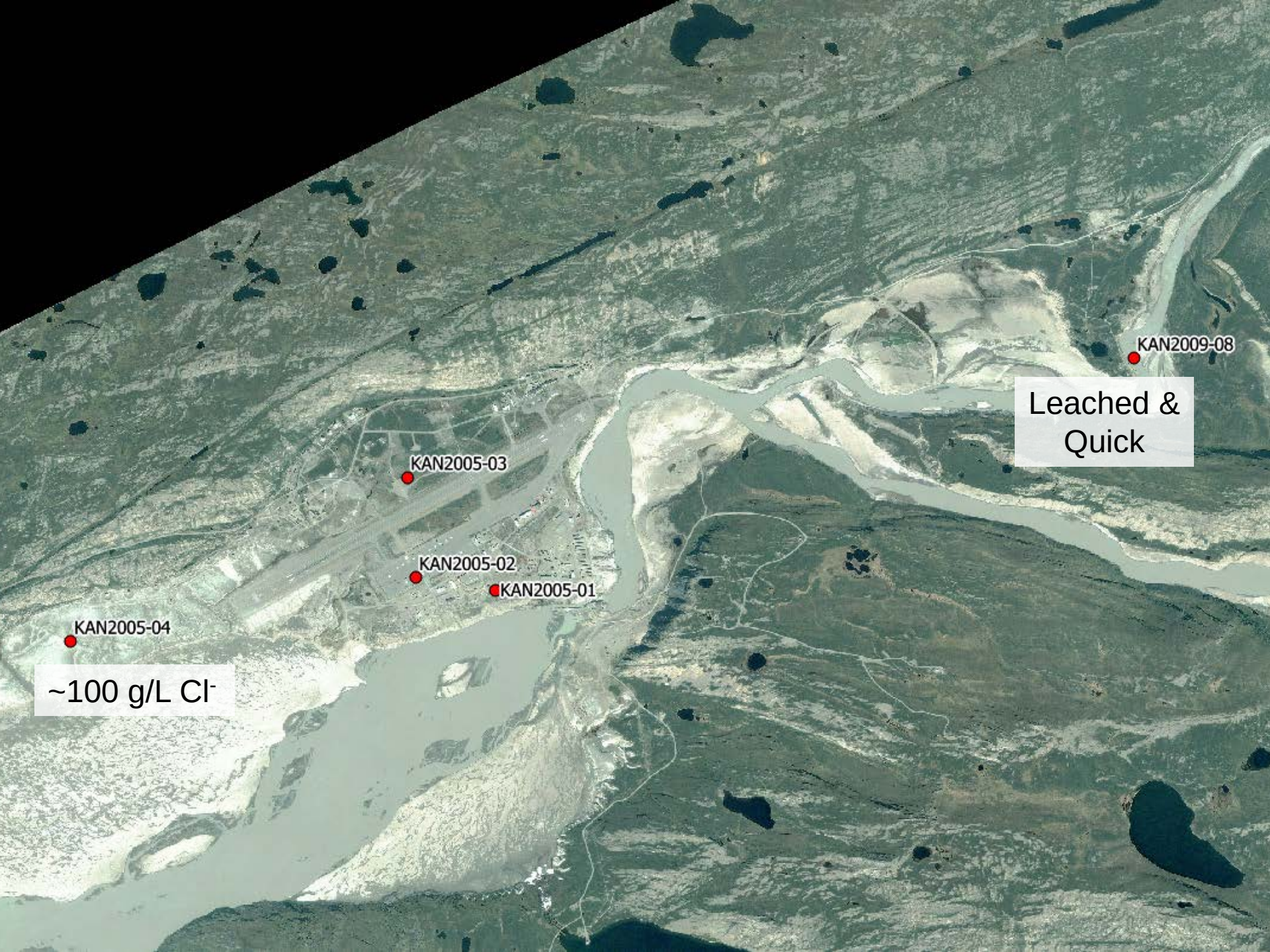




Boreholes & Test pits



Fine grained, typically ice rich (where not saline)



KAN2009-08

Leached &
Quick

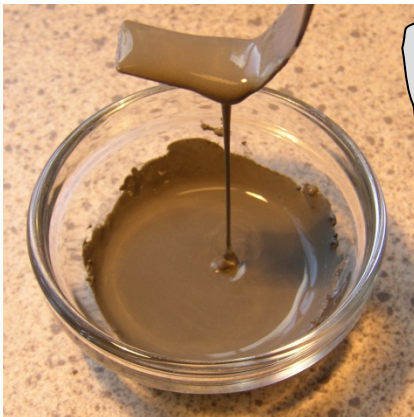
KAN2005-03

KAN2005-02

KAN2005-01

KAN2005-04

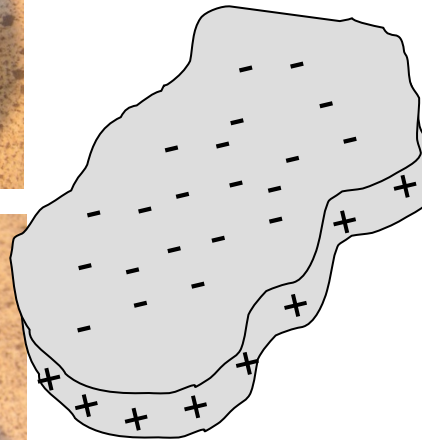
~100 g/L Cl⁻



Clay particles sedimented in freshwater
Disperse structure...



Clay particles sedimented in sea water
Flocculated structure...

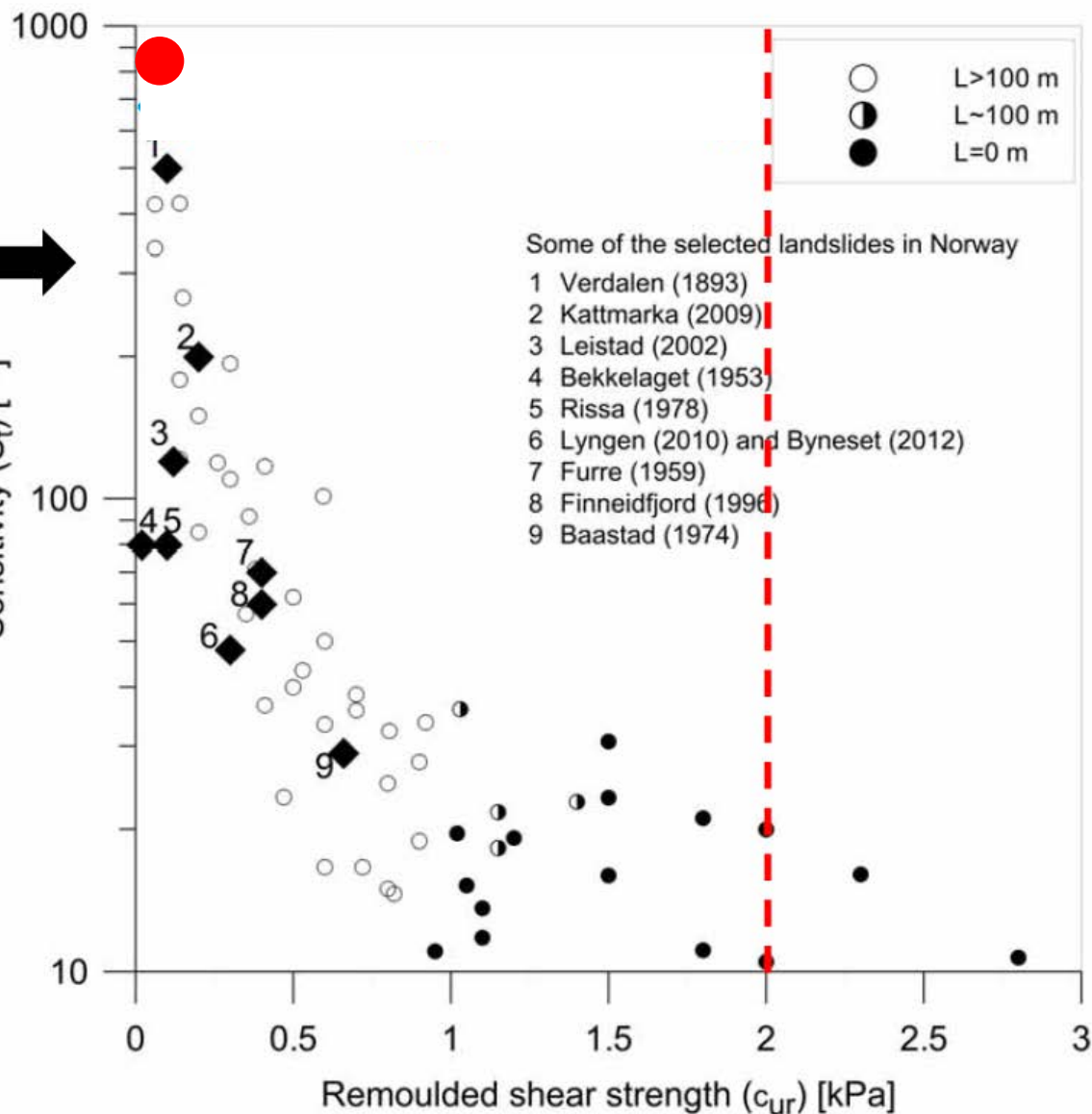


L > 100 m

1	Duedalen	1625
2	Bakkalandet	1634
3	Tiller	1816
4	Kokstad	1924
5	Gretnes	1925
6	Brå	1928
7	Ullensaker	1953
8	Selnes	1965
9	Hekseberg	1967
10	Othilienborg	3500 BP
11	Langørjan	Prehistoric
12	Lund	Prehistoric
13	Sjtnesmarka	Prehistoric
14	Olderdalen	Prehistoric
15	Gullaug	Prehistoric
16	Heimstad	Prehistoric
17	Stavset	Prehistoric



Sensitivity (S_t) [-]

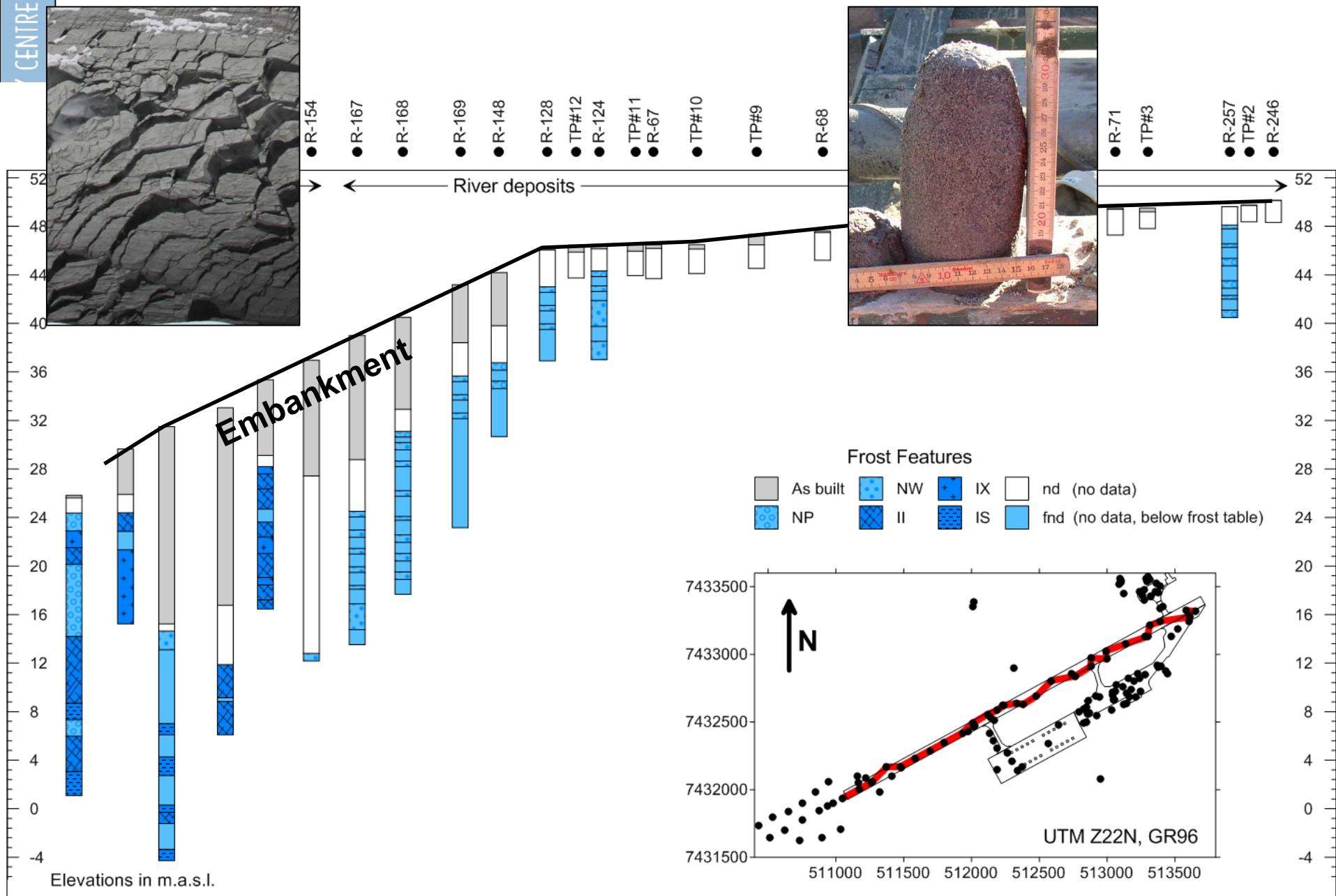


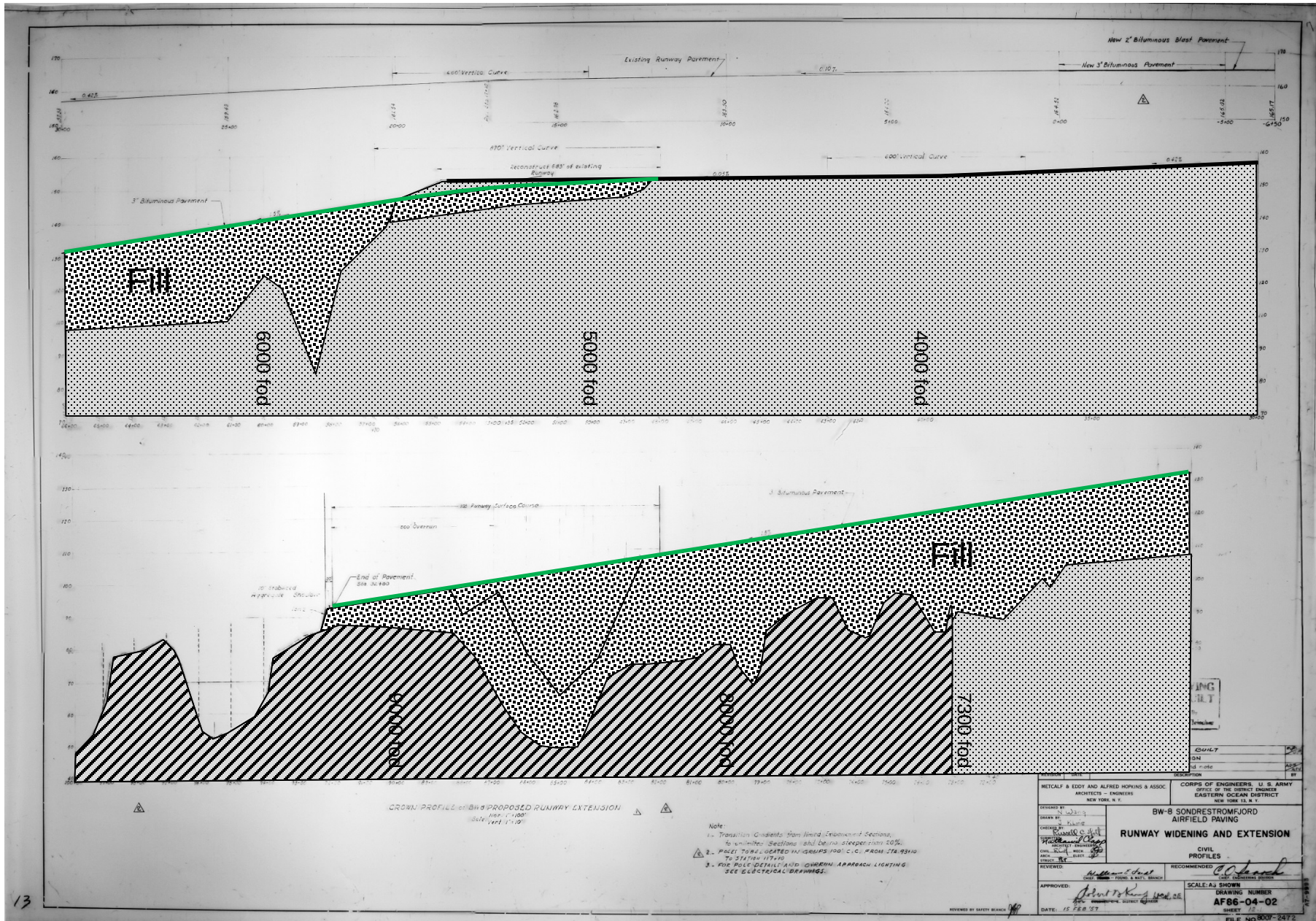
vegvesen.no

Conclusions

- Complex and interesting geological setting
- (most of the) Runway has very limited risk of thaw settlements
- Thaw settlements in western-most section have little/no impact on operational safety
- Maintenance issues must be properly handled (crack sealing, drainage etc)
- Thaw settlements on southern aprons are severe, but likely limited due to thickness of ice rich deposits

Qujanaq!

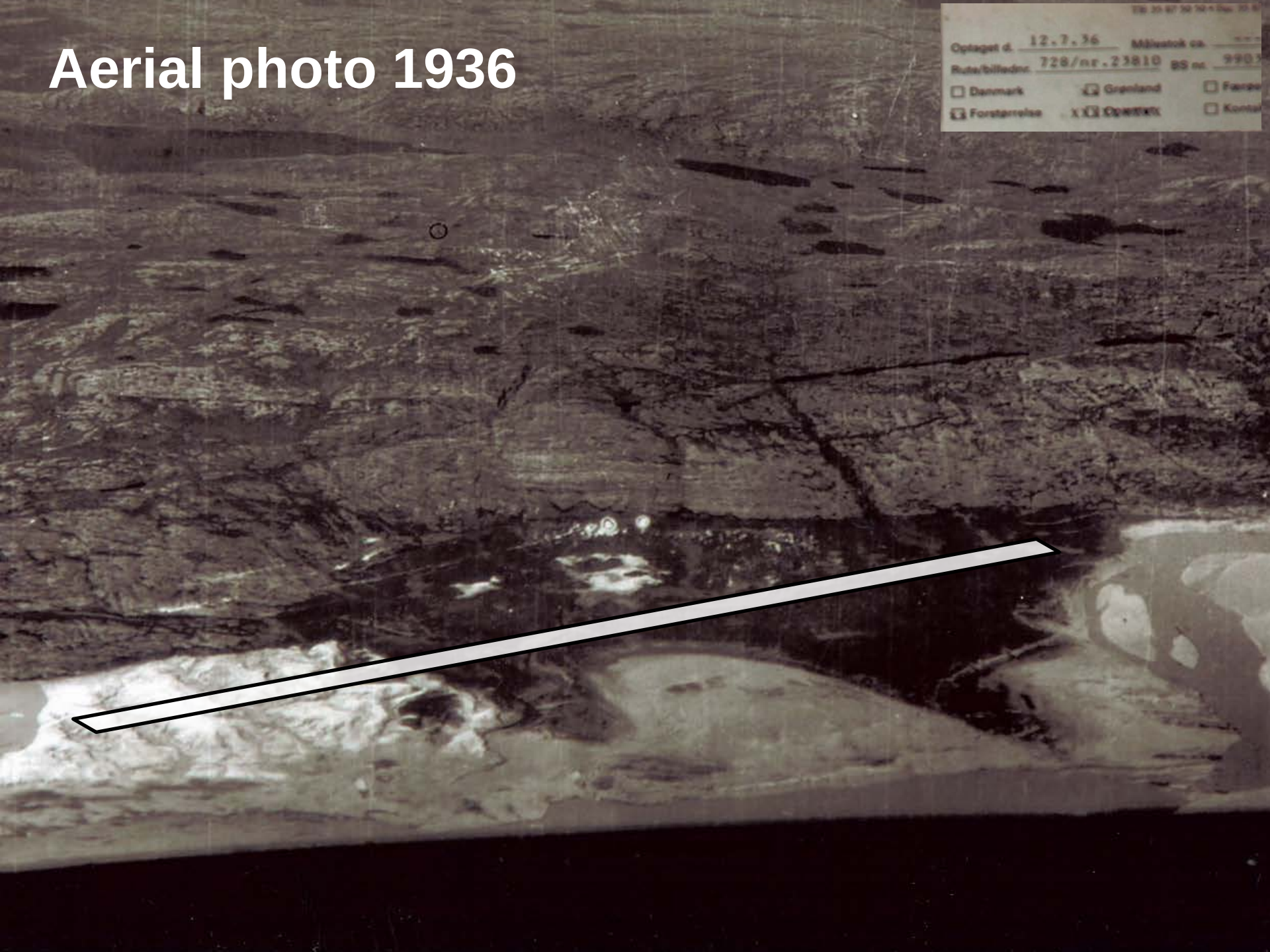


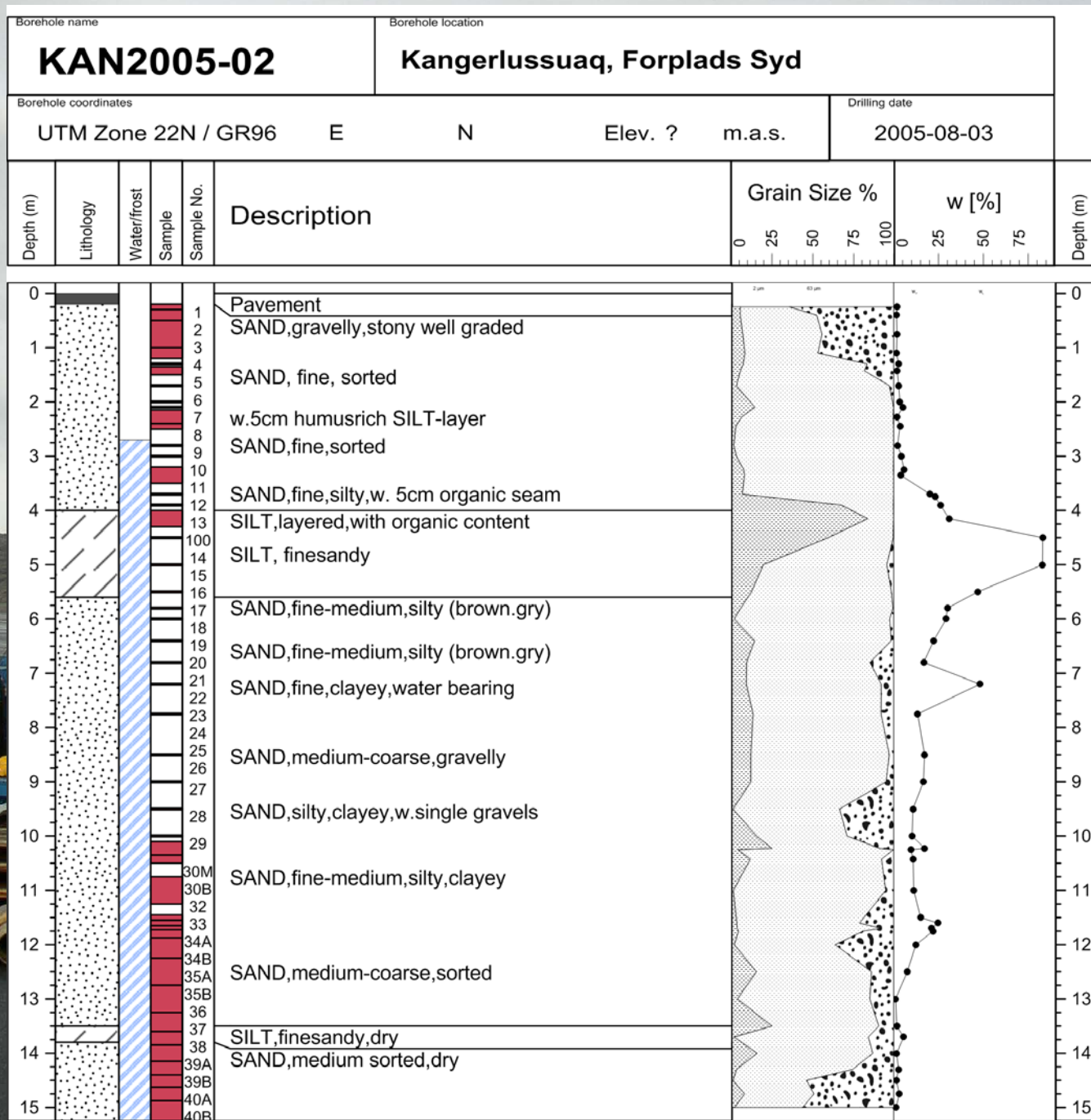


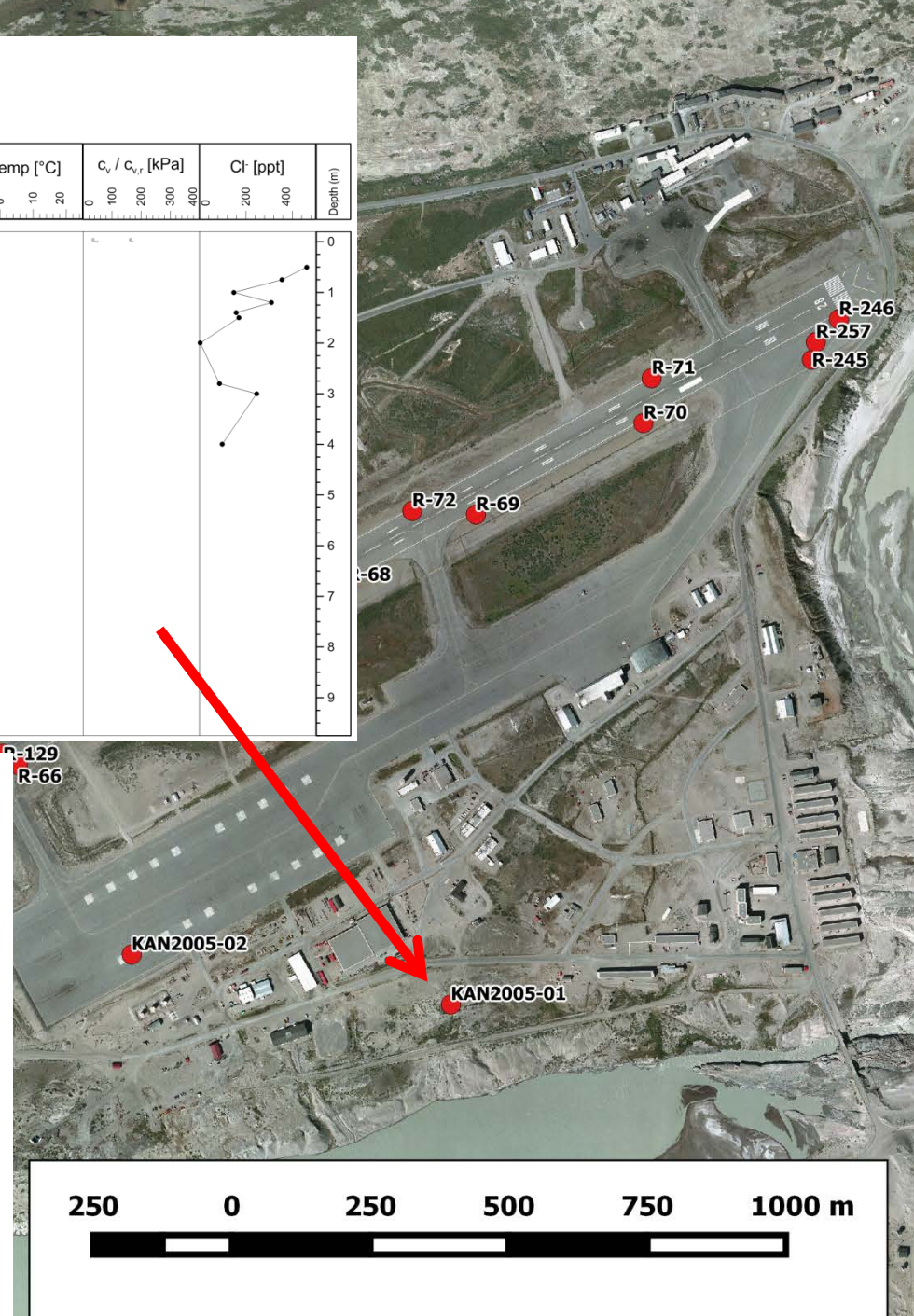
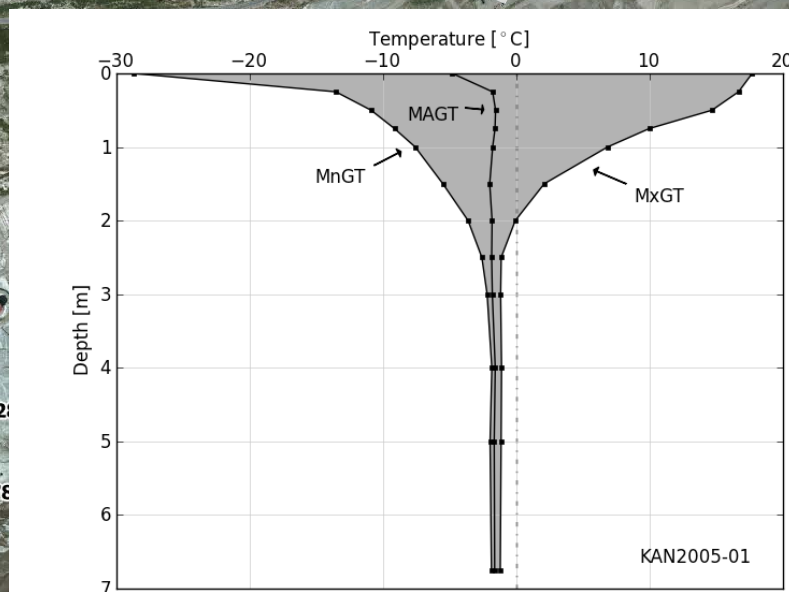
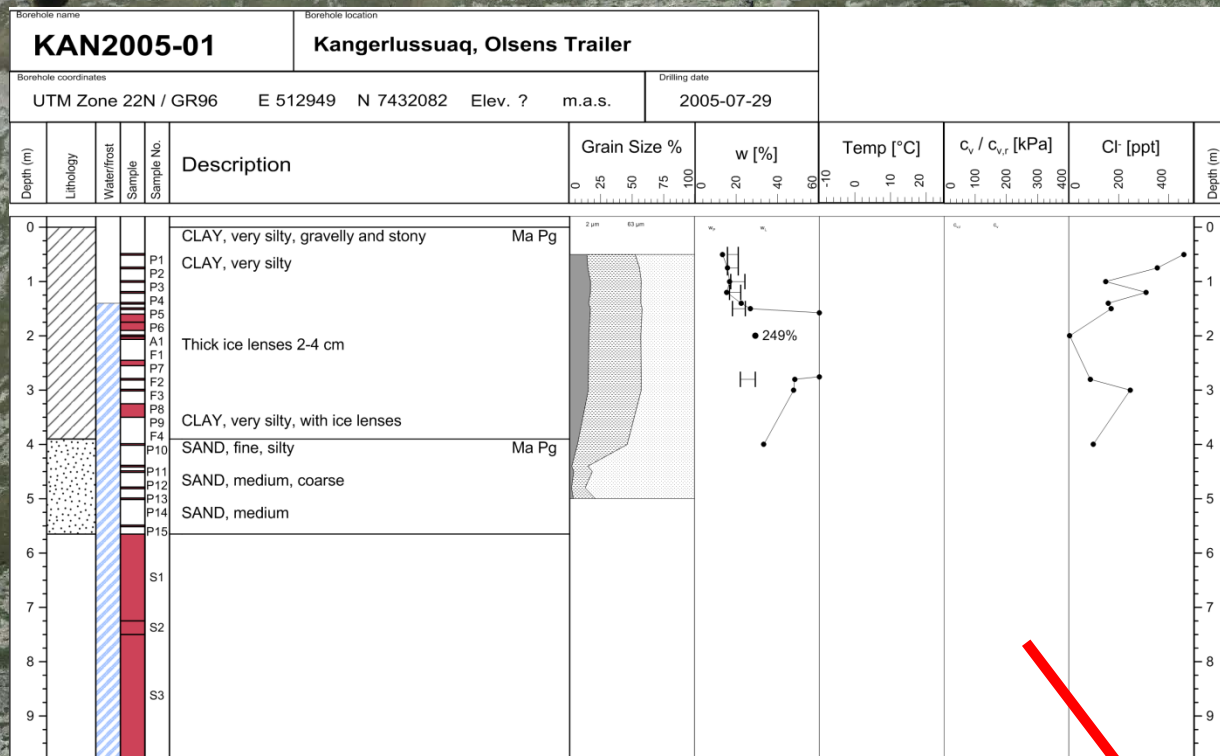
Aerial photo 1936

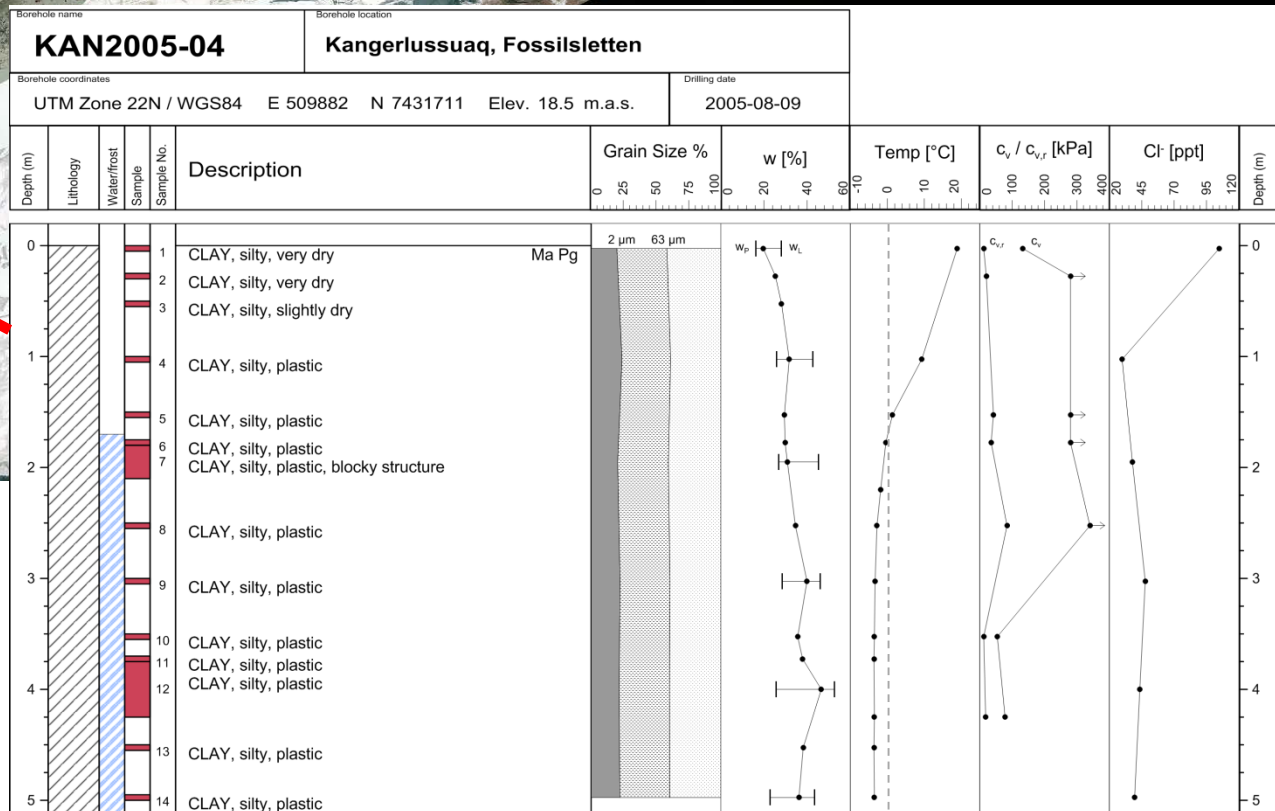
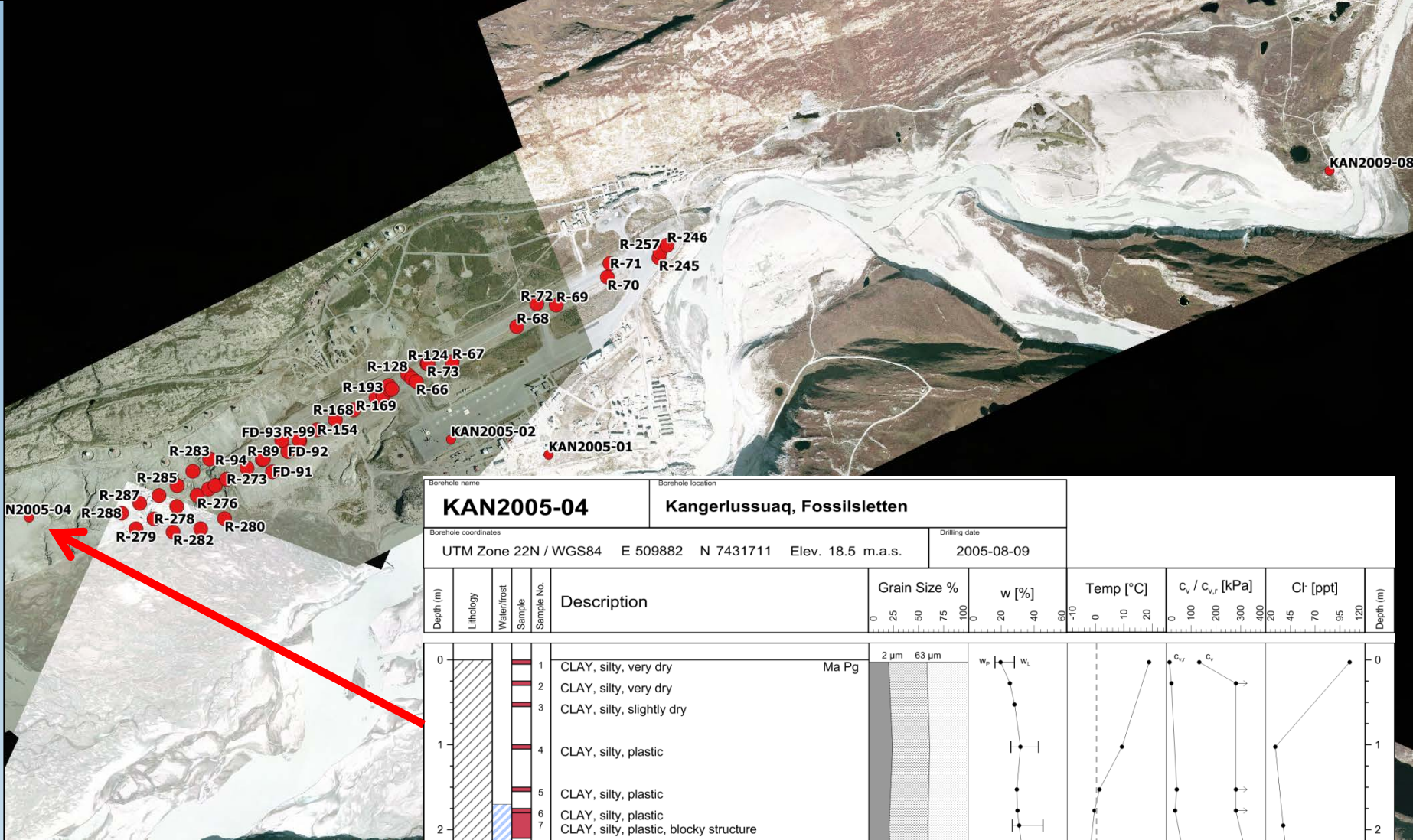
120 35 47 50 52 + 53 54 55

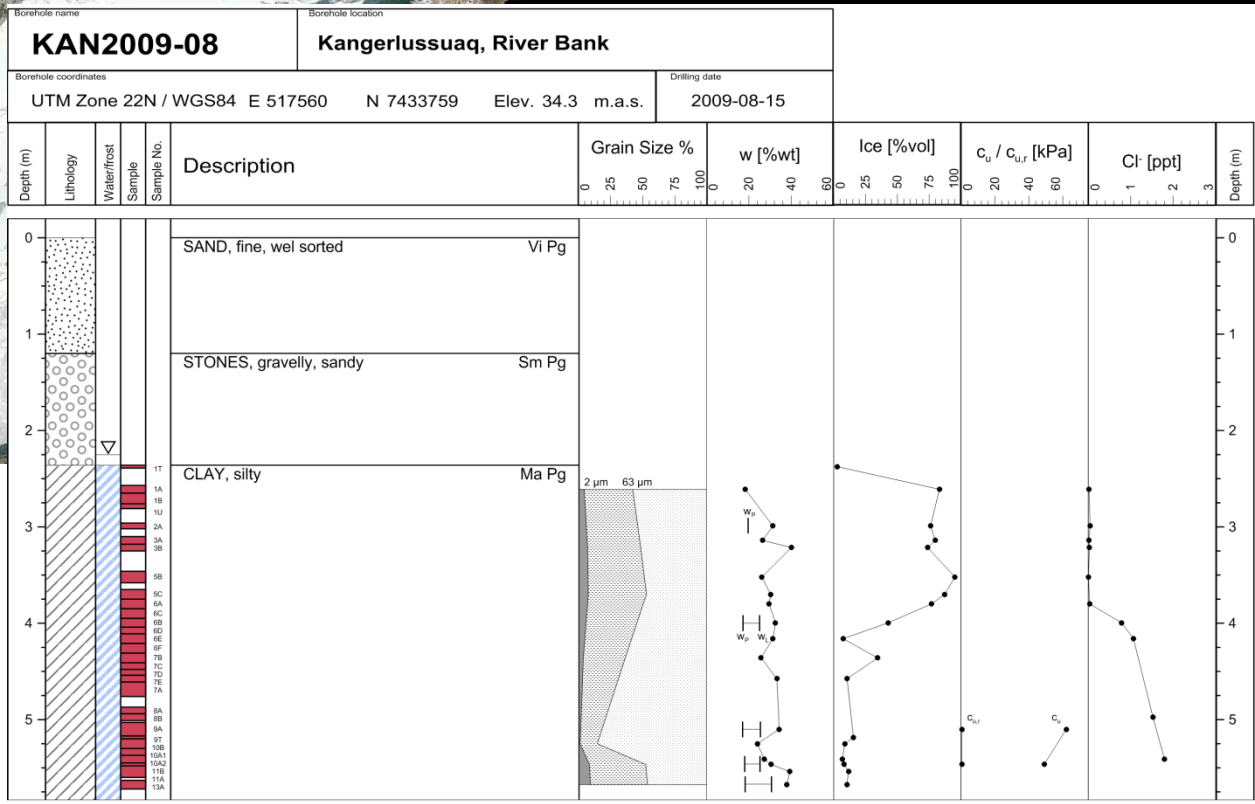
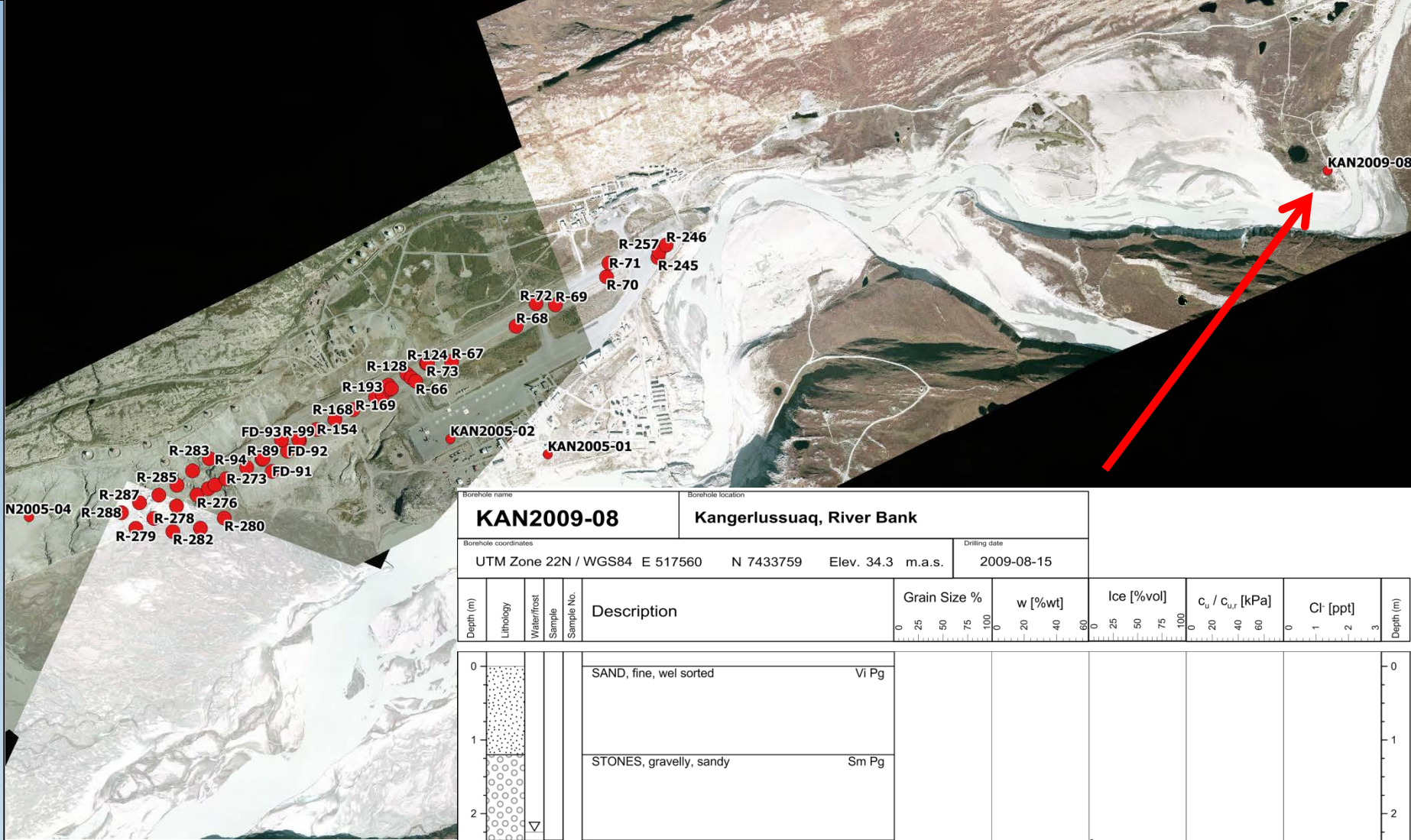
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Rute/billednr.	728/nr. 23810	BS nr.	9903
☐ Danmark	☒ Grønland	☐ Færøer	
☒ Forstørrelse	XIX	☒ Kontar	

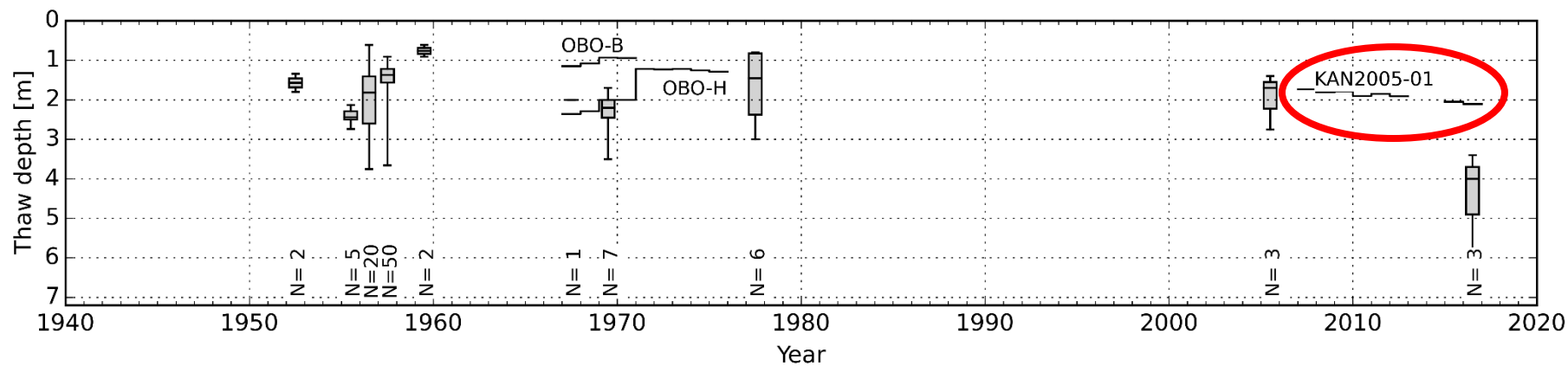
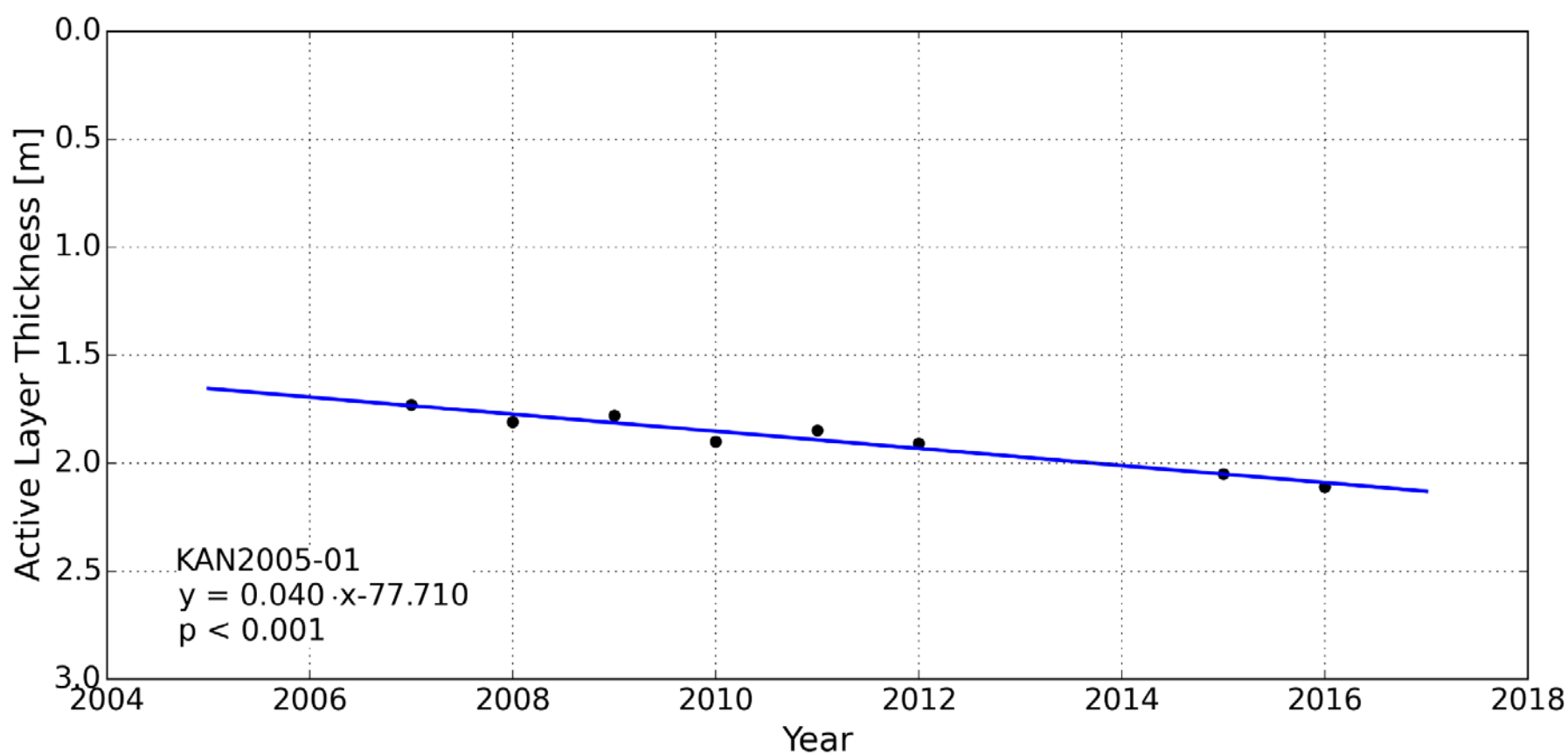


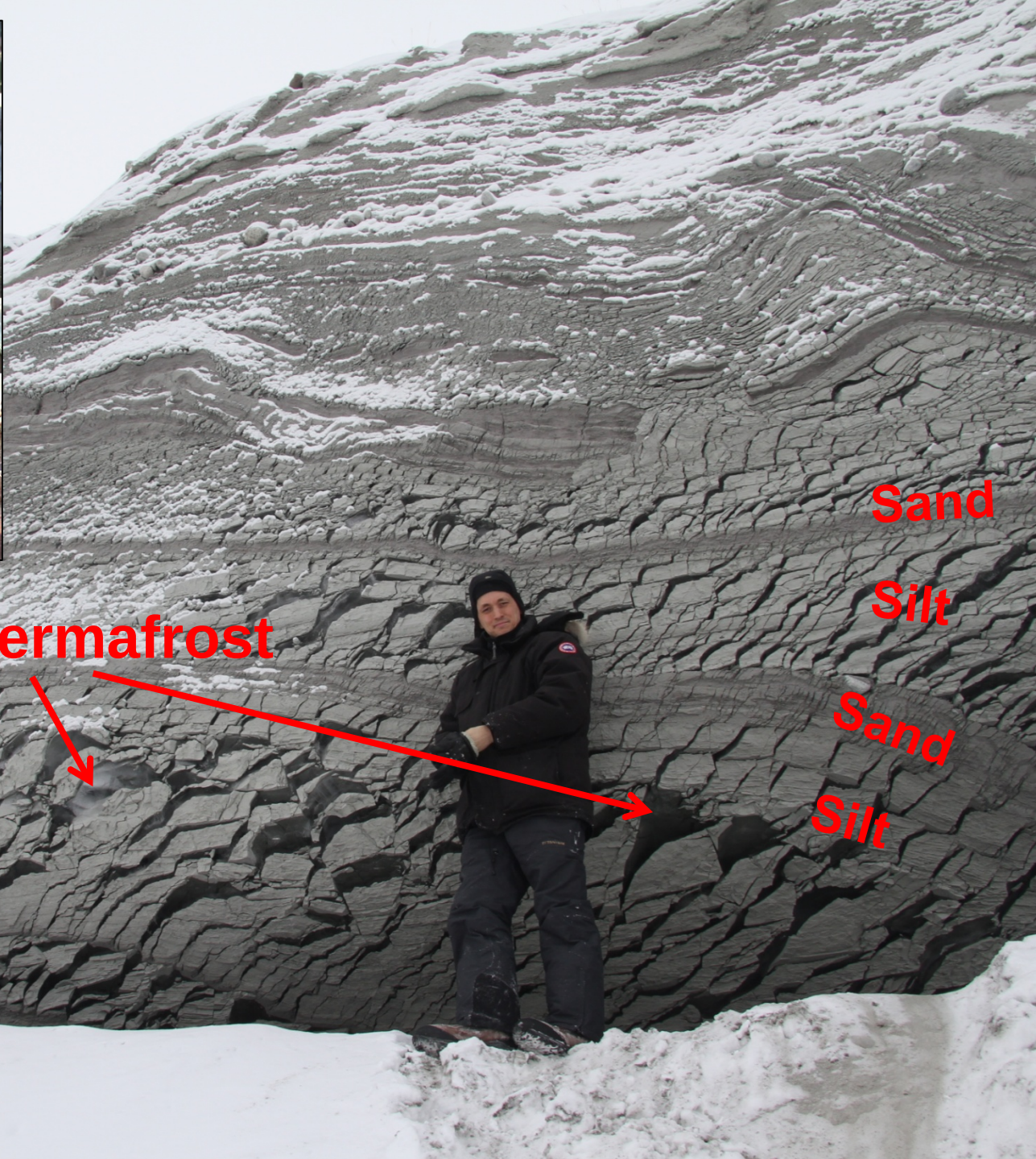












Ice in the permafrost

Sand

Silt

Sand

Silt

Table 10.2 Comparison of airstrip lengths and materials in the BBDS region.

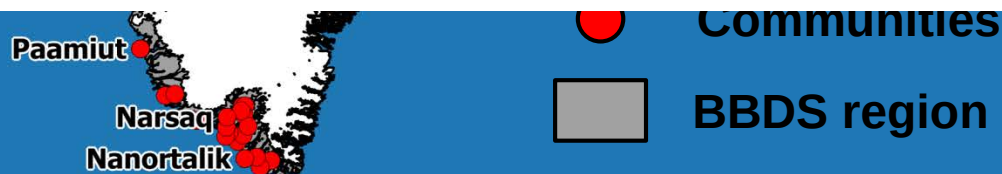
Canadian side of the BBDS region ¹			West Greenland ²		
Airport	Material	Length (m)	Airport	Material	Length (m)
Iqaluit	Asphalt	2,623	Thule	Asphalt	3,000
Resolute	Gravel	1,982	Kangerlussuaq	Asphalt	2,815
Alert*	Gravel	1,676	Narsarsuaq	Concrete	1,830
Mary River**	Gravel	1,463	Nuuk	Asphalt	950
Pond Inlet	Gravel	1,221	Qaanaaq	Gravel	900
Cape Dorset	Gravel	1,216	Qaarsut	Gravel	900
Arctic Bay	Gravel	1,199	Ilulissat	Asphalt	845
Qikiqtarjuaq	Gravel	1,159	Aasiaat	Asphalt	799
Clyde River	Gravel	1,067	Maniitsoq	Asphalt	799
Pangnirtung	Gravel	890	Paamiut	Asphalt	799
Grise Fiord	Gravel	606	Sisimiut	Asphalt	799
Kimmirut	Gravel	579	Upernavik	Asphalt	799

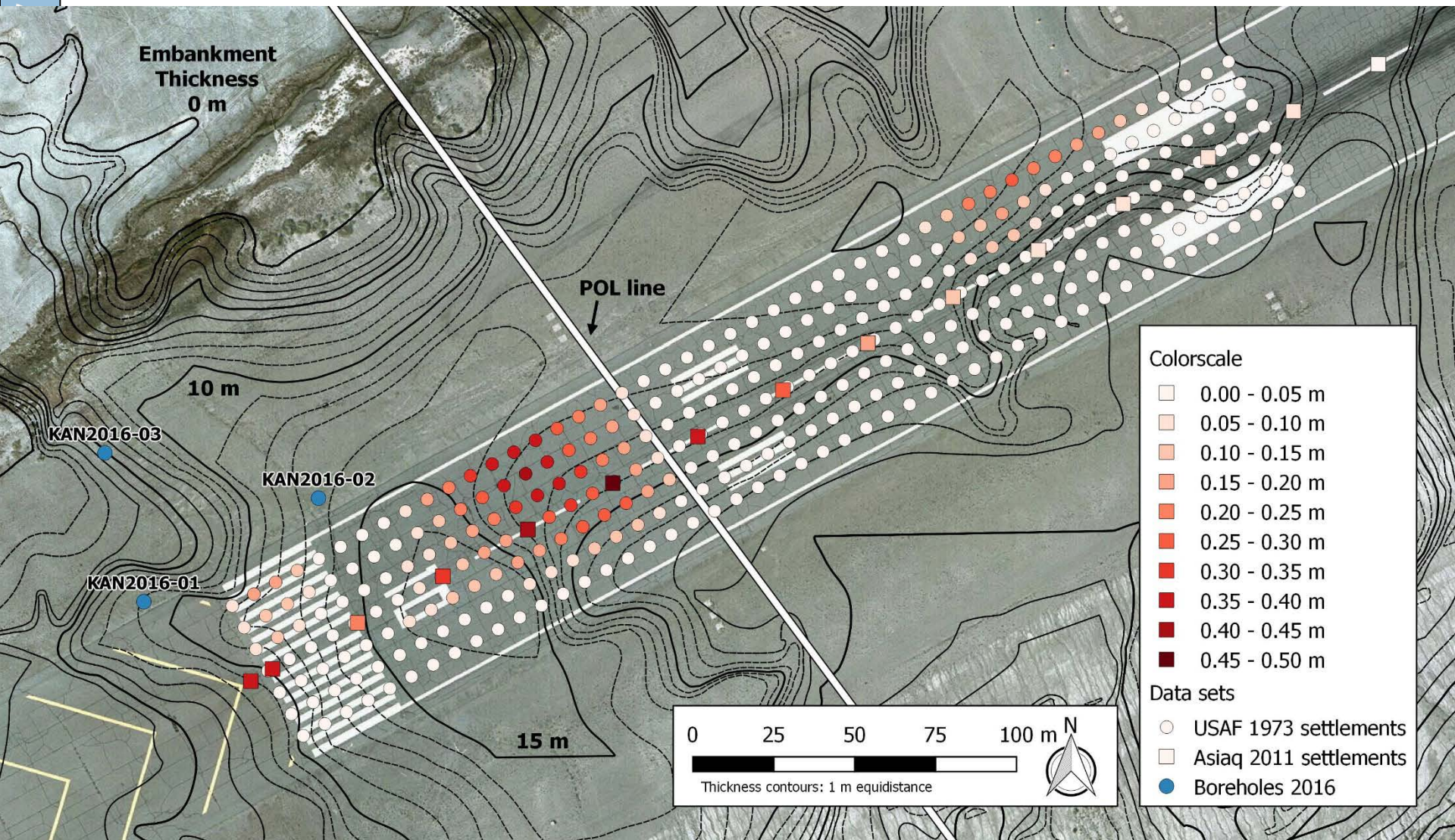
¹ Source: NAV Canada (2008)

² Source: Transportkommissionen (2011)

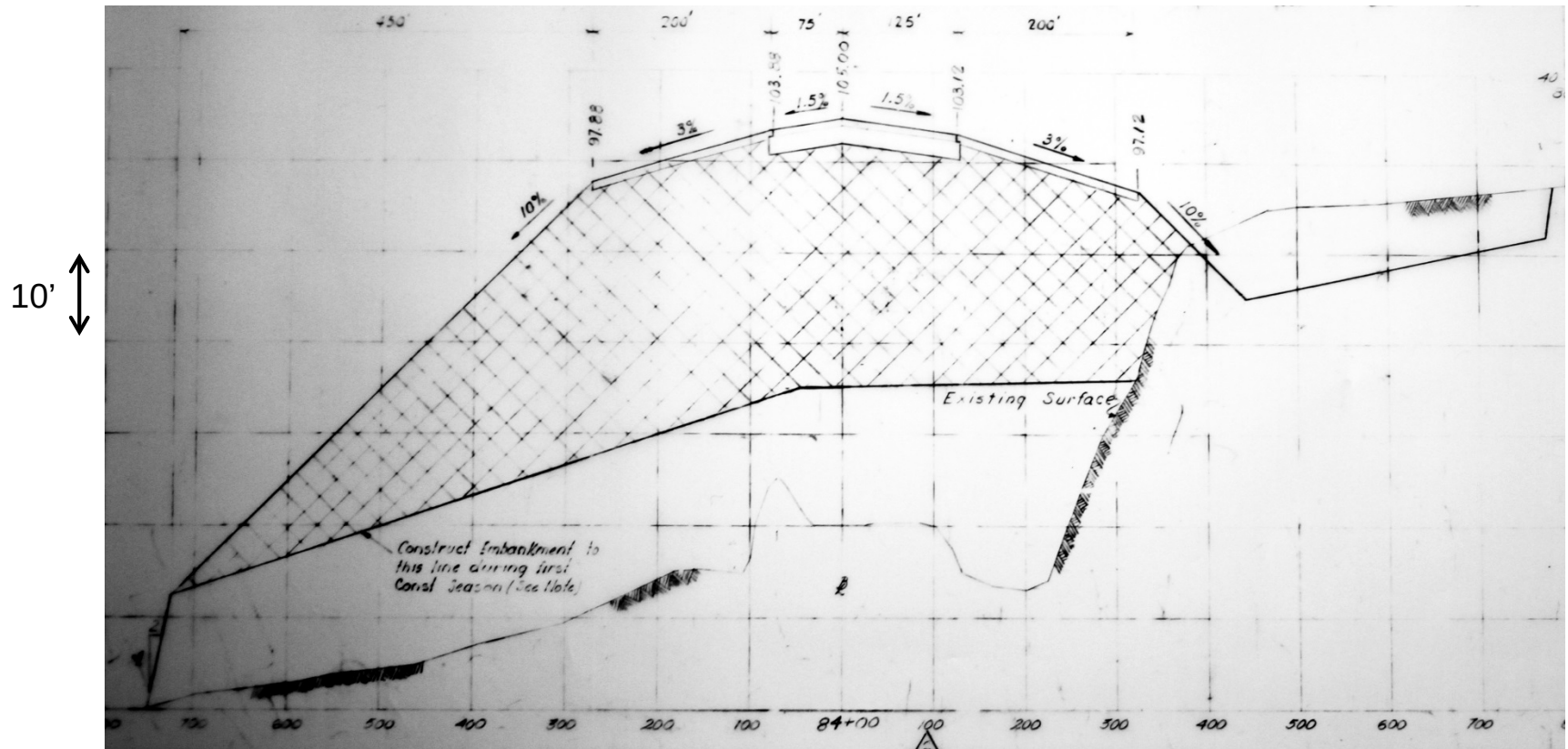
* Canadian Forces Station

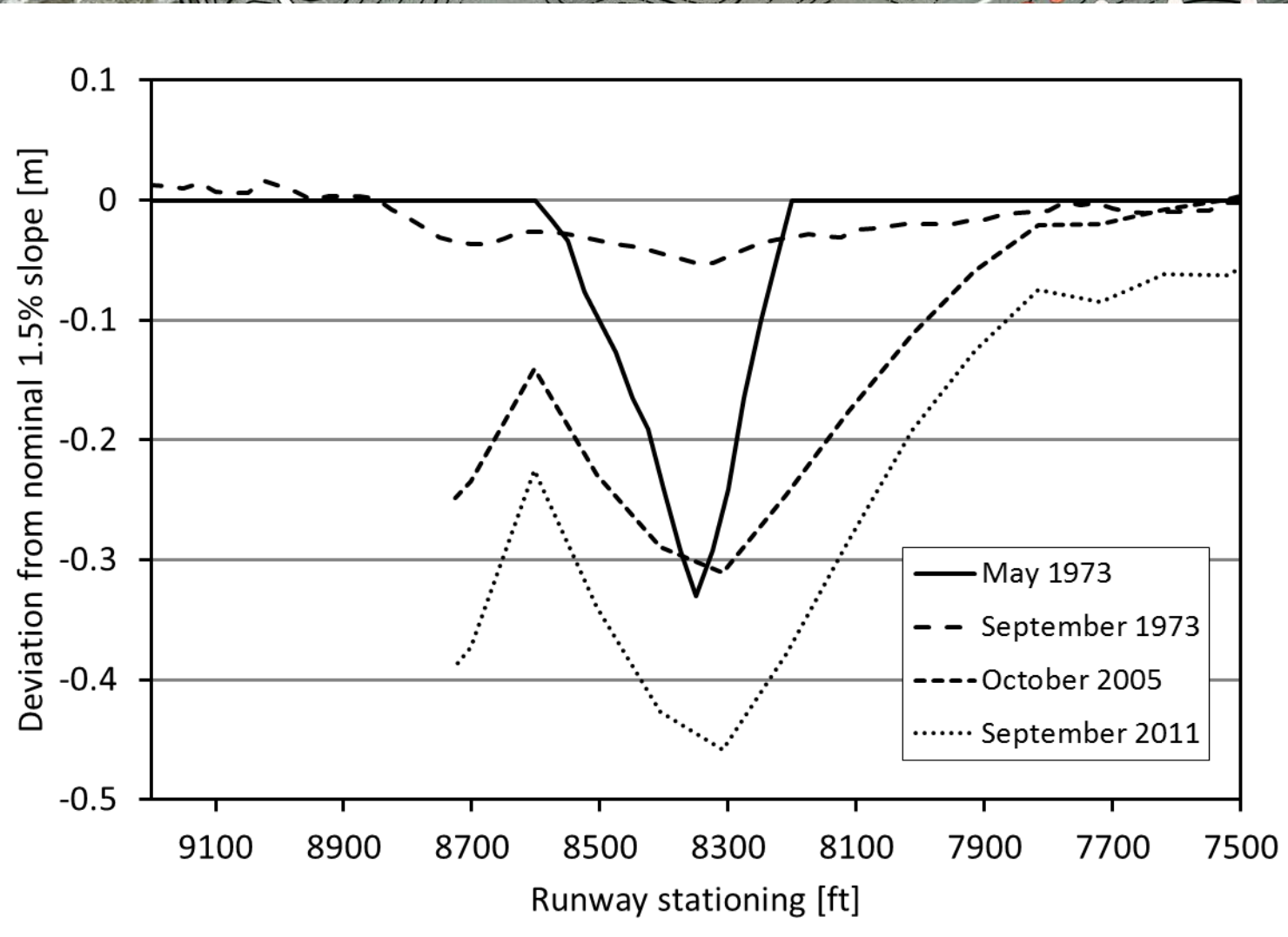
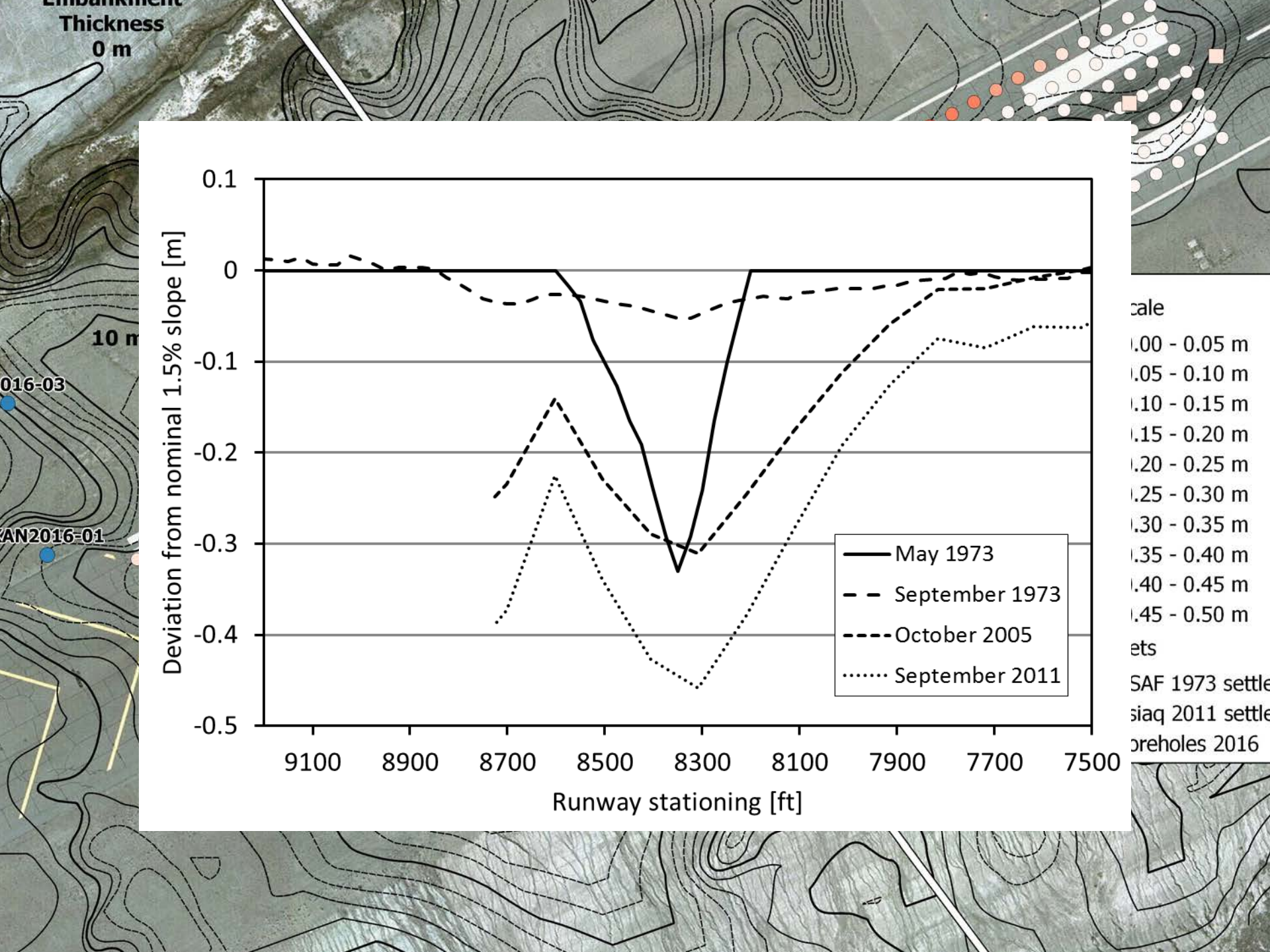
** Private airport operated by Baffinland Iron Mines Corporation





Crosssection at 8400' (2560 m)







Ice in the permafrost

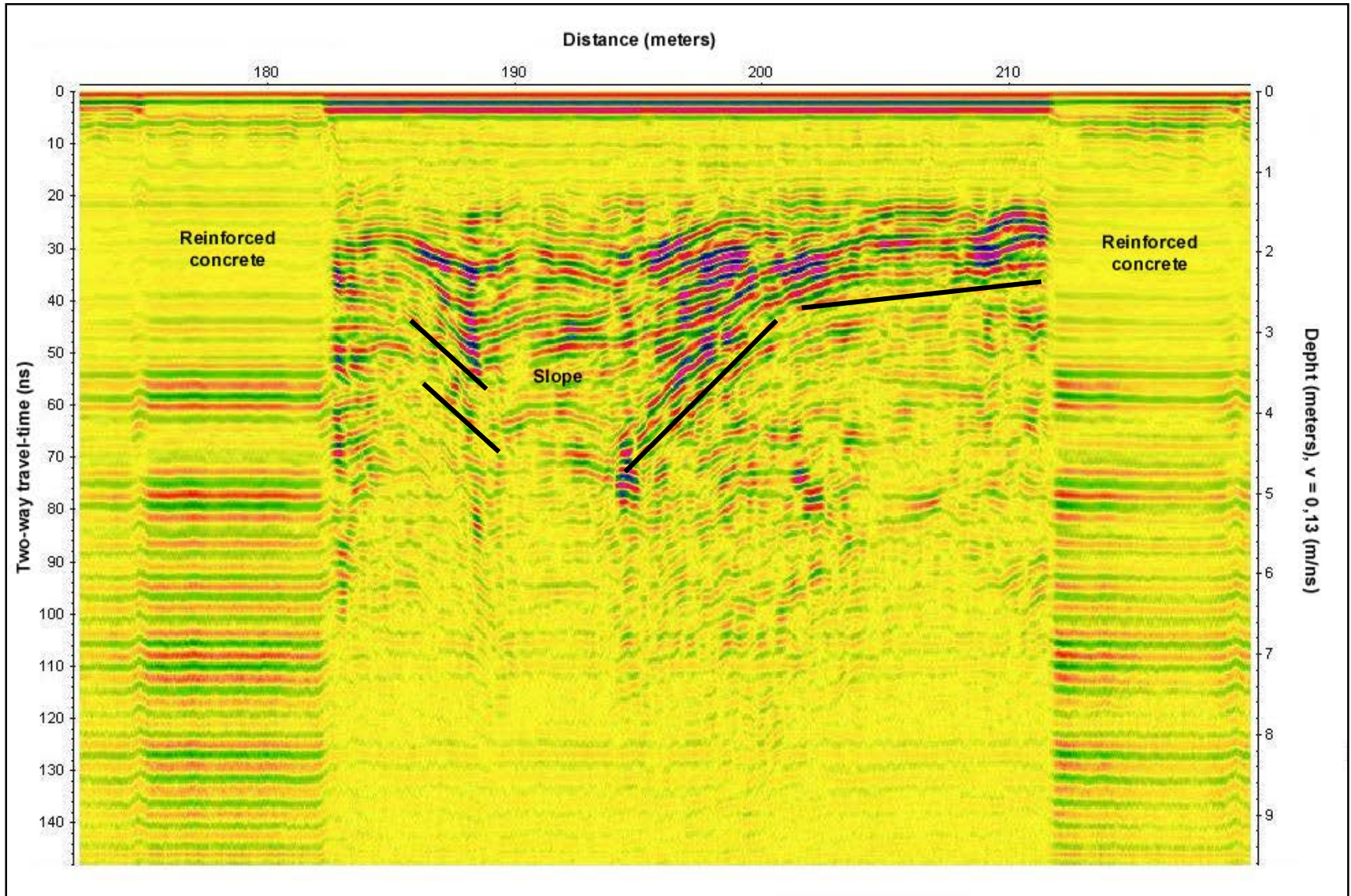
Sand

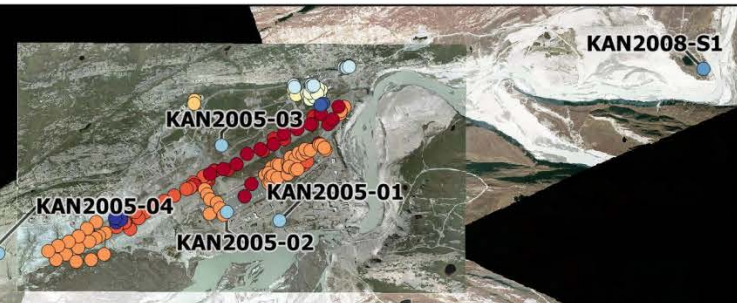
Silt

Sand

Silt

Kangerlussuaq Airport (350 MHz)





Boreholes & Test pits

- 1952 1969
- 1955 1977
- 1956 2005
- 1957 2008
- 1959 2011
- 1967 2016

