Englacial lake dynamics within a Pleistocene Cordilleran ice sheet at Kima Kho tuya (British Columbia)

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Abstract

Passage zones are stratigraphic surfaces found in littoral settings separating deposits diagnostic of subaqueous environments from overlying sequences of subaerial deposits. In glaciovolcanic settings, passage zone surfaces are unequivocal records of the heights and depths of paleo-englacial lakes at a specific point in time and space thereby informing on the presence and nature of the enclosing ice sheet. Kima Kho, a Pleistocene glaciovolcano (i.e. tuya) features multiple and diverse passage zones. The basaltic volcano comprises 4 main stratigraphic packages: i) subaqueously and subaerially deposited lapilli tuffs forming a central tephra cone and representing an explosive onset to the eruption, ii) subaqueously deposited, steeply-inclined beds of tuff breccia dominated by pillow lava fragments, iii) stacked sheets of subaerial lavas , and iv) dykes and sills (I) intruding all units. Stratigraphic and geochemical relationships suggest that Kima Kho volcanism was continuous and 40Ar/39Ar geochronometry on 3 samples yields a mean age of 1949 ±63 ka. Three temporally distinct passage zones record the interplay between growth of the volcanic edifice, syn-volcanic melting of the enclosing ice sheet, and fluctuations in the depth of the englacial lake. The earliest passage zone is expressed in two different ways indicating a transition to effusive eruption: (i) within pyroclastic deposits of the tephra cone (< 1800 masl), and (ii) by pillow lava tuff breccia deposits overlain by subaerial lavas. Together they record a peak, sustained lake depth of 320-340 m that constrains the enclosing ice sheet to a minimum thickness of ˜400 m and a minimum radial extent >7 km relative to Kima Kho. Two subsequent passage zones, also defined by sequences of subaerial lavas resting on dipping beds of pillow lava tuff breccias, occur at lower elevations: 1690-1640 masl and 1740-1720 masl, respectively. The latter two passage zones indicate a major draining of the englacial lake followed by refilling to depths of 230-180 m and 260-280 m, respectively. The substantial decline in lake level between passage zones suggests a massive, catastrophic deluge (i.e. jökulhlaup) of 1-2 km3. Lastly, the reconstructed evolution of Kima Kho demands the presence of a regionally extensive, cold-based ice sheet on the Kawdy plateau at ˜1.9 Ma.

Englacial Lake Dynamics within a Pleistocene Ice Sheet, Kima' Kho Tuya, Canada

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Marie Turnbull
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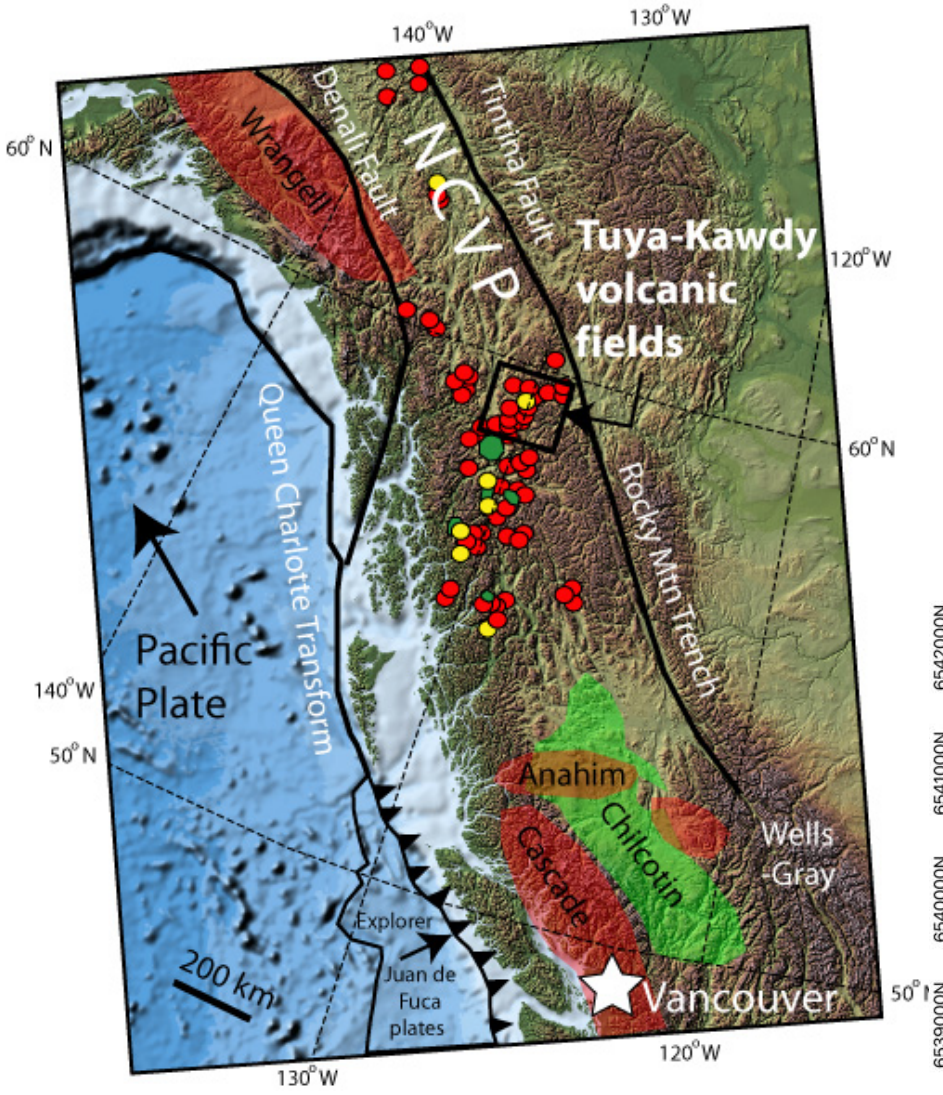
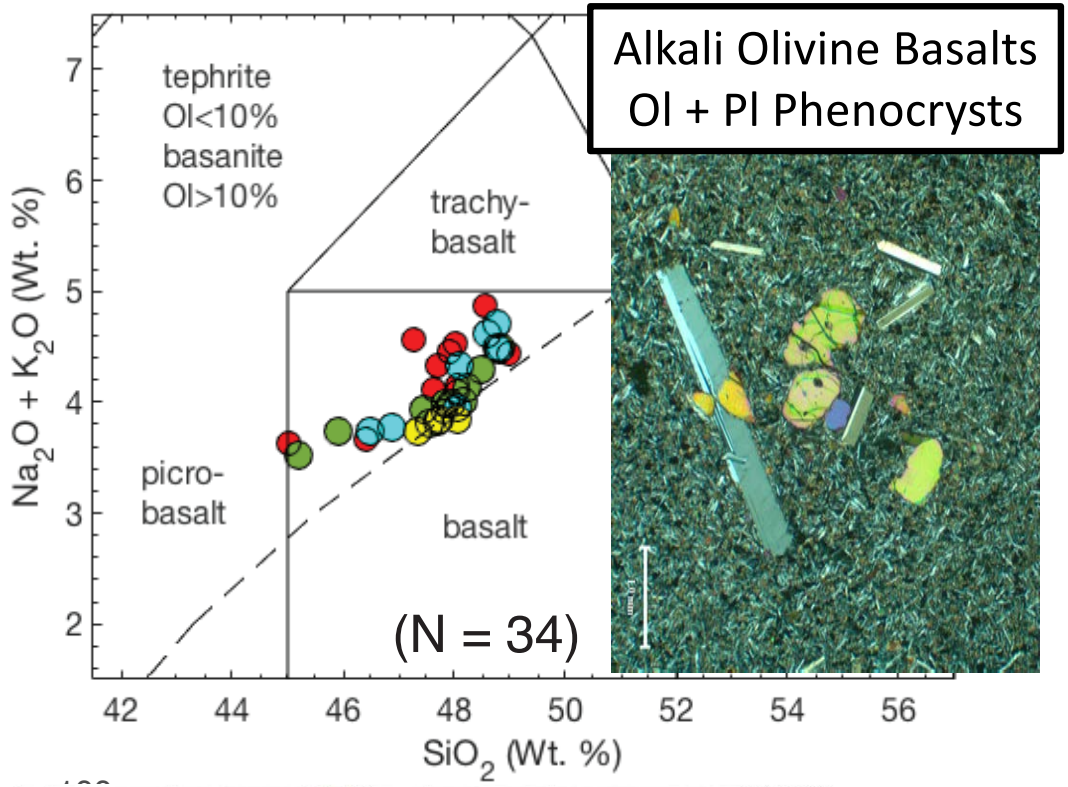
Quaternary Science Reviews (2021)

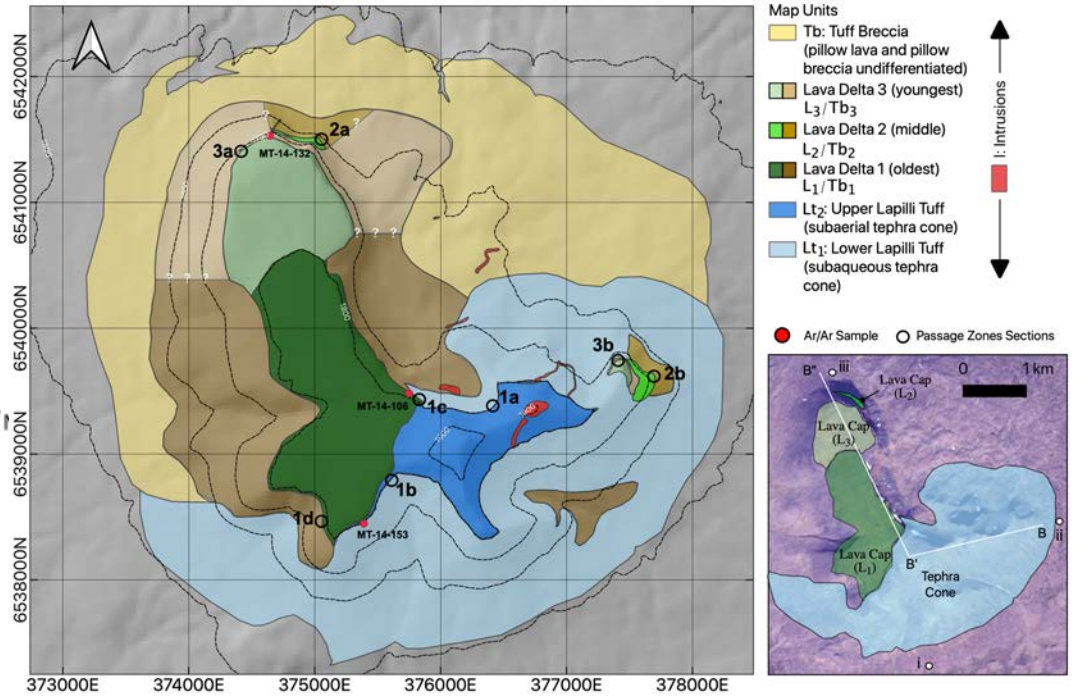
OUTLINE

A) Kima' Kho tuya (glaciovolcano) dated at 1943 +/- 63 ka
B) Basaltic tuya featuring explosive onset followed by effusion
C) Multiple (3) & Diverse (4) "***Passage Zones***"
D) Passage zones establish:
    - syn-eruptive englacial lake dynamics
    - minimum thickness of Pleistocene incarnation of CIS

Northern Cordilleran Volcanic Province
Tuya-Teslin Area

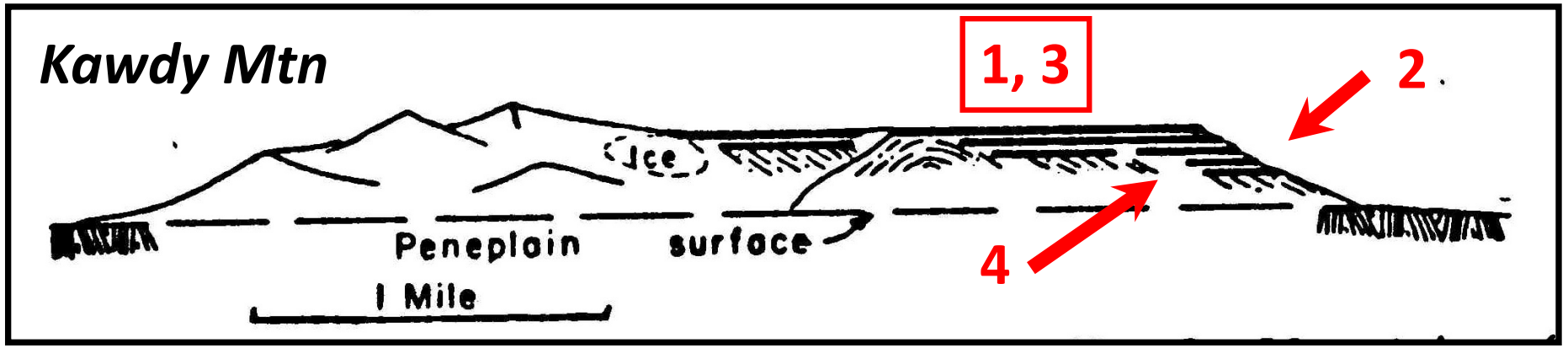






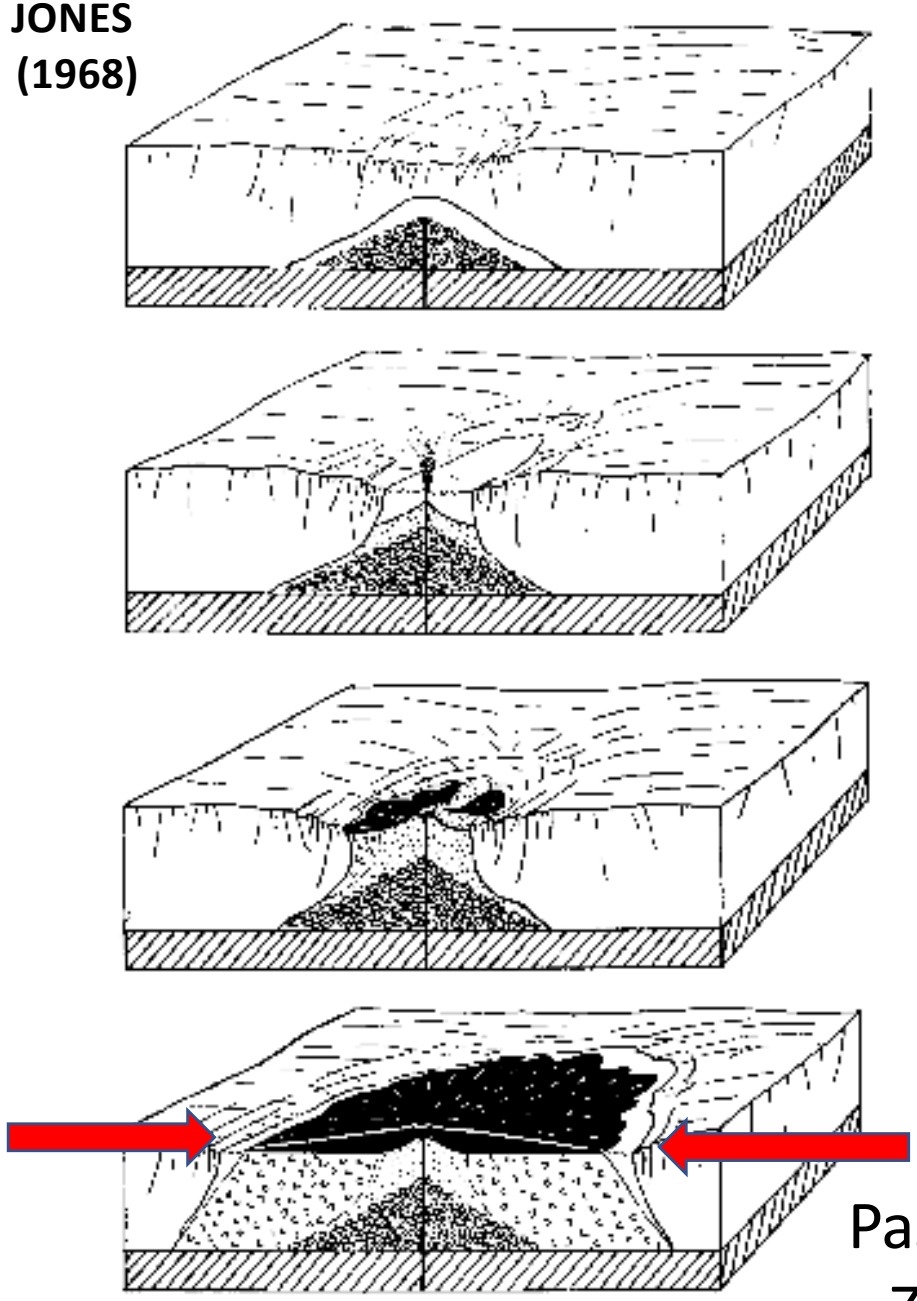
Mathews, WH 1947. “Tuyas”, Flat-Topped volcanoes in northern BC. Amer. J. Sci., V. 245, 560-570.

TUYAS: **Flat-topped (1), steep sided (2) volcanoes comprising horizontal beds of basaltic lava (3) resting on outward dipping beds of fragmental rocks (4).**



[+Tuya Butte, Isspah Butte, Ash Mtn, Mathew’s Tuya, No. 1 & 3]]

JONES
(1968)



Passage
Zone

"*Passage zones*"

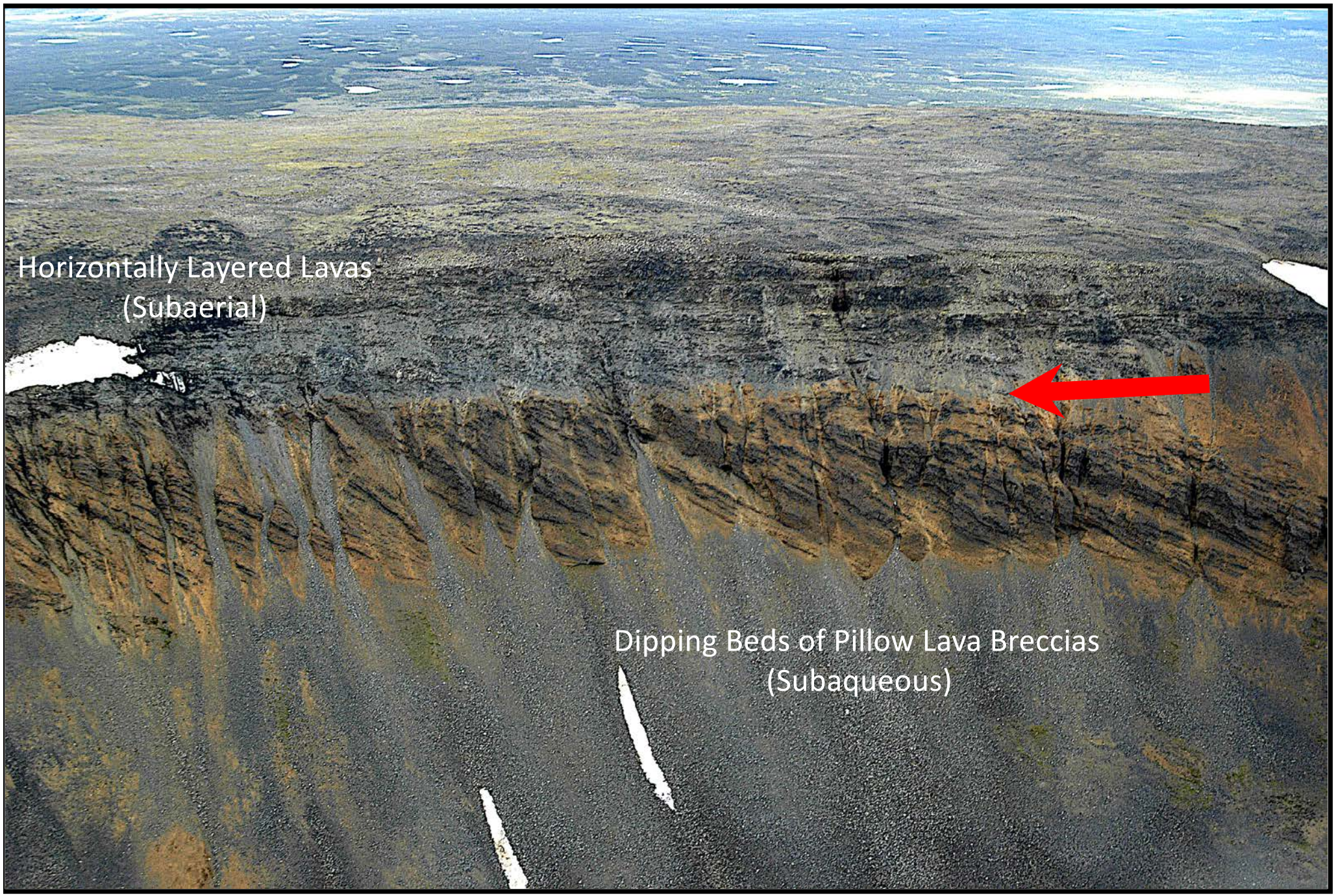
….. diachronous surfaces marking transitions between subaqueous and subaerial environments during volcanic eruptions.

….. the elevation of the passage-zone surface records the height and depth of the paleo-englacial lake.

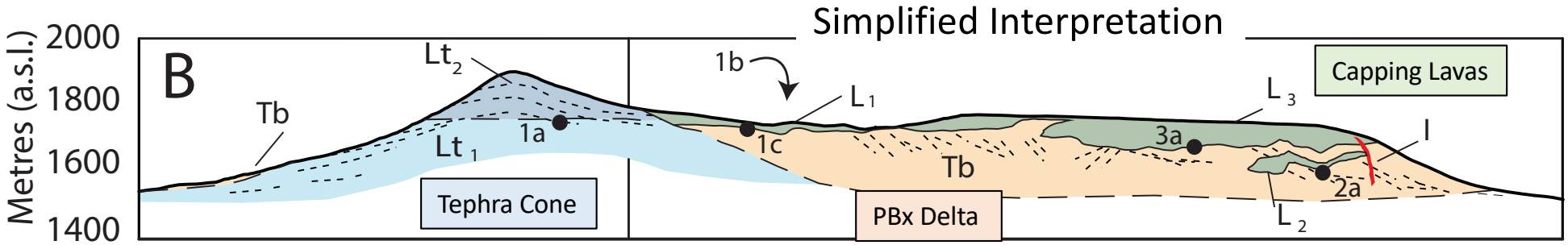
….. fixes the minimum thickness of the enclosing ice sheet …..

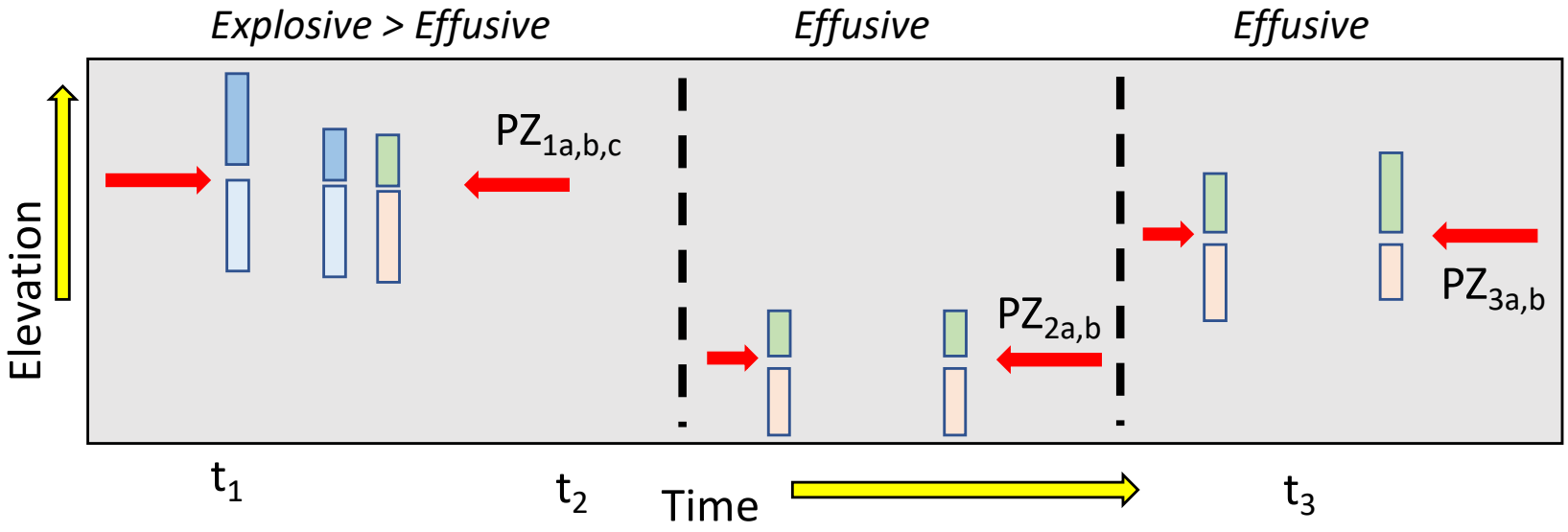
Russell et al. Nature Comm (2013)

Passage Zone at Kima'Kho

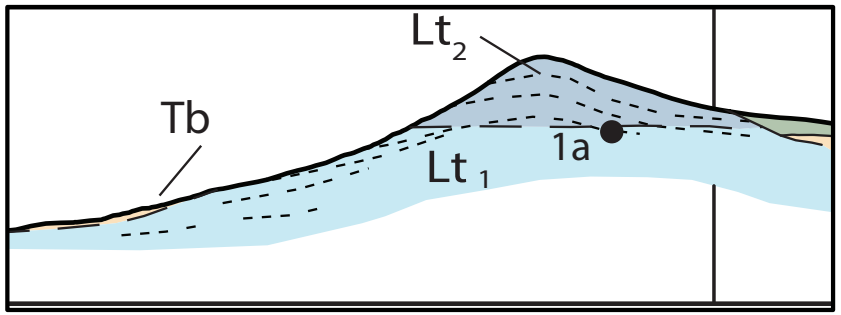


Multiple (3) & Diverse (4) "***Passage Zones***"

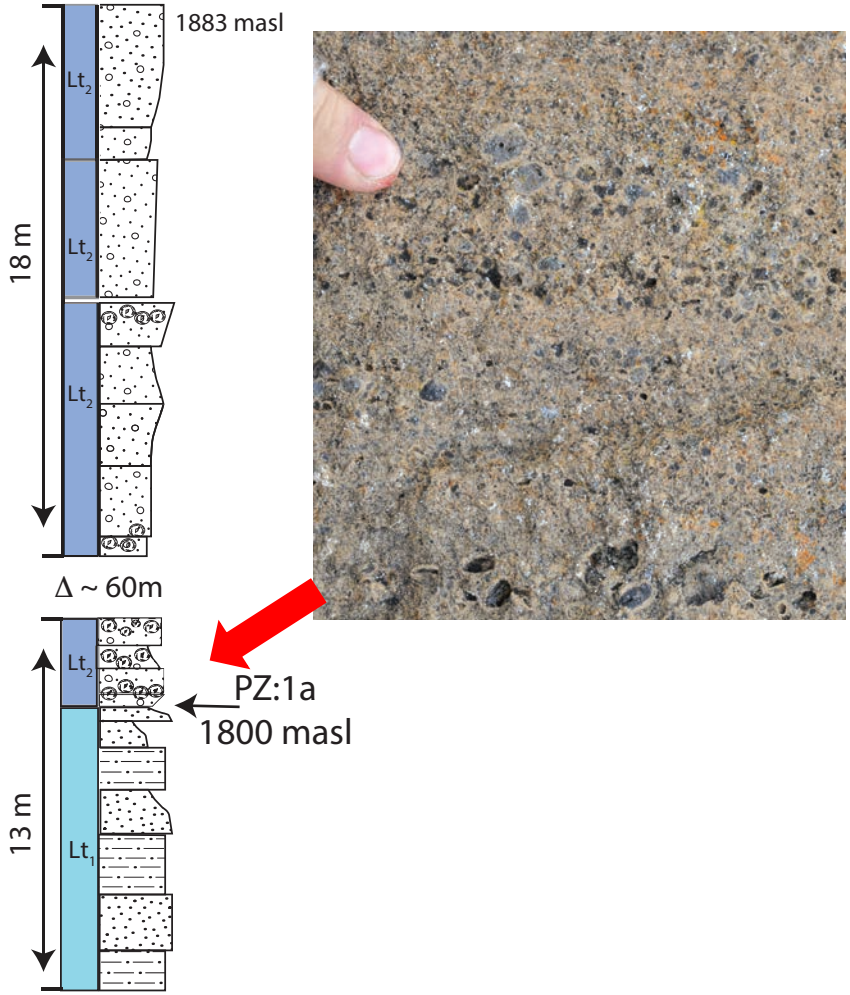




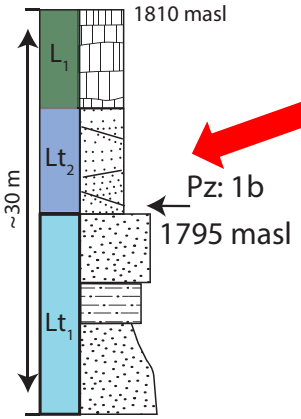
Passage Zones (1a, 1b) Defined by Pyroclastic Lithofacies

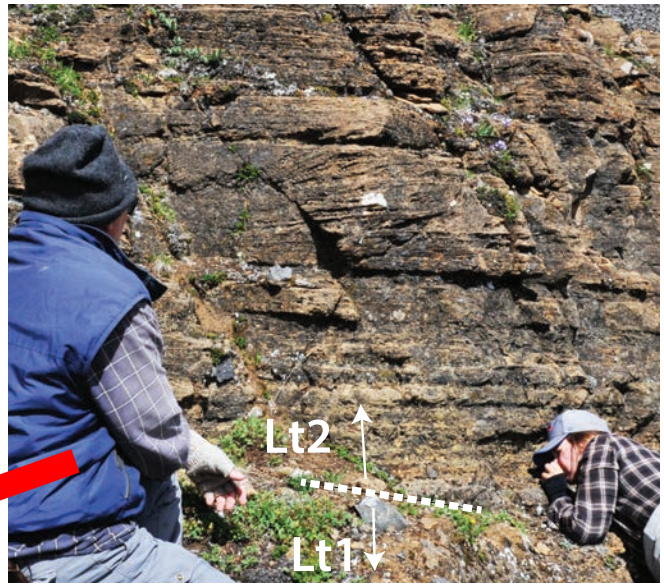


1a

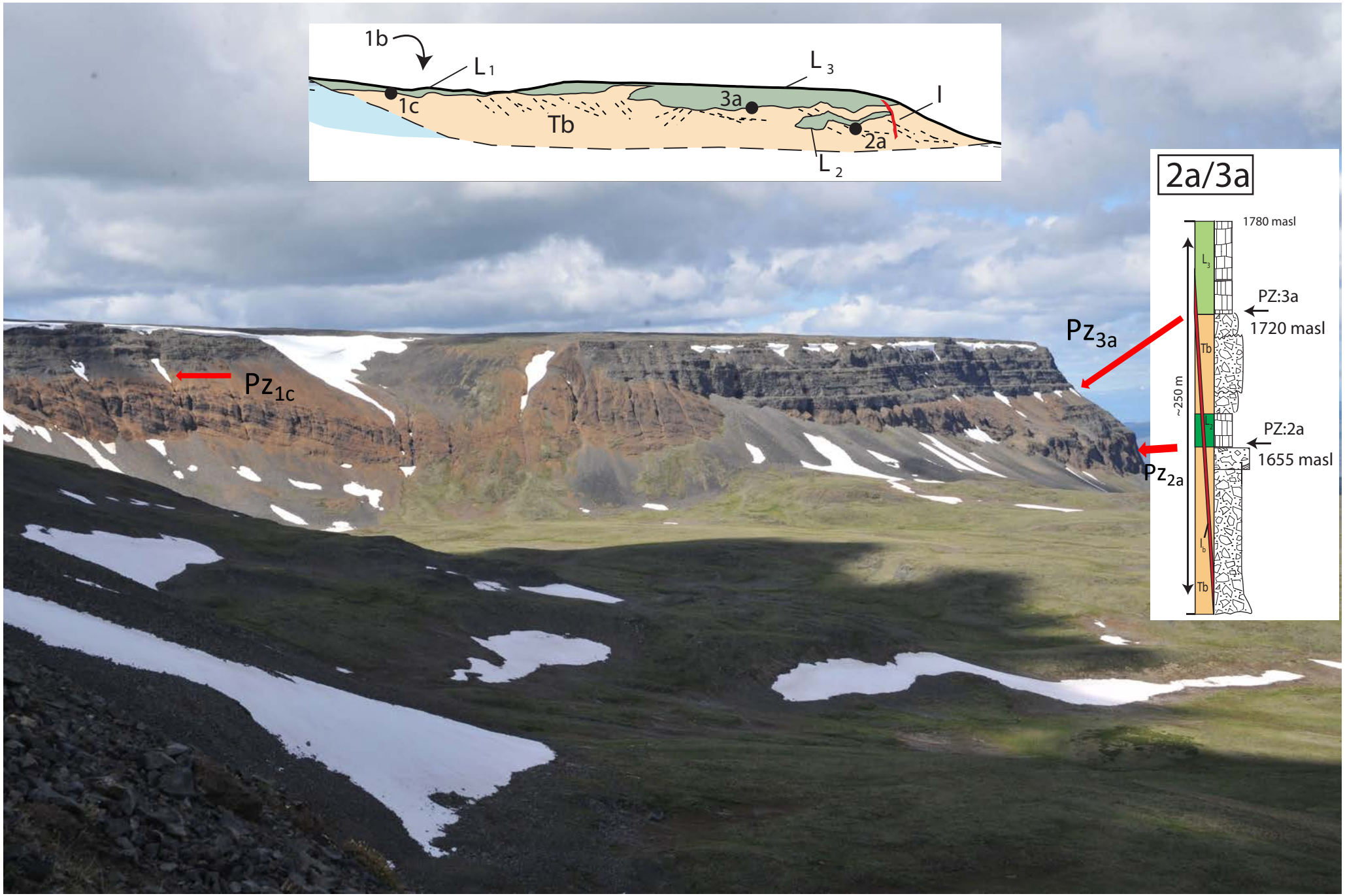


1b

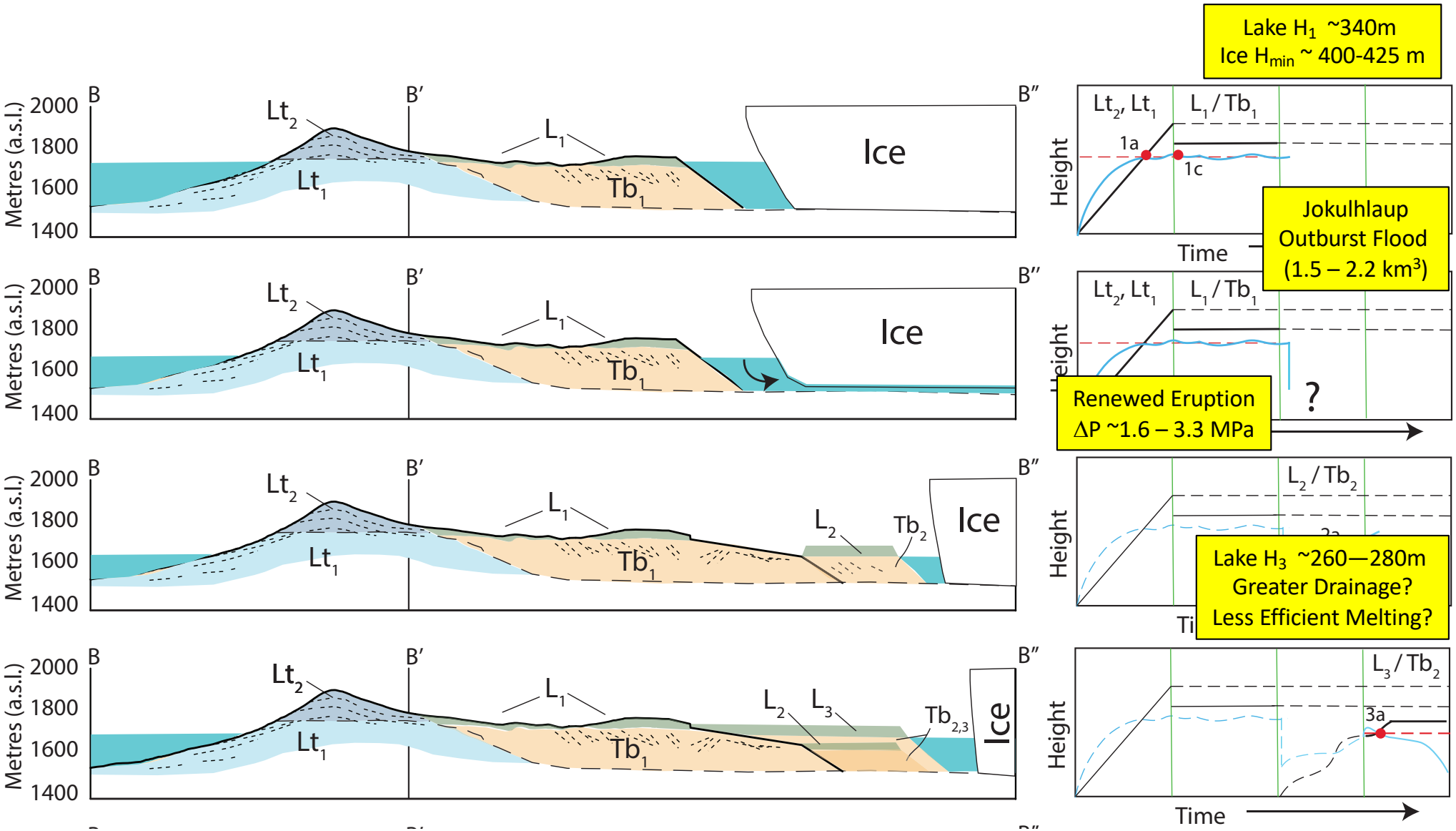




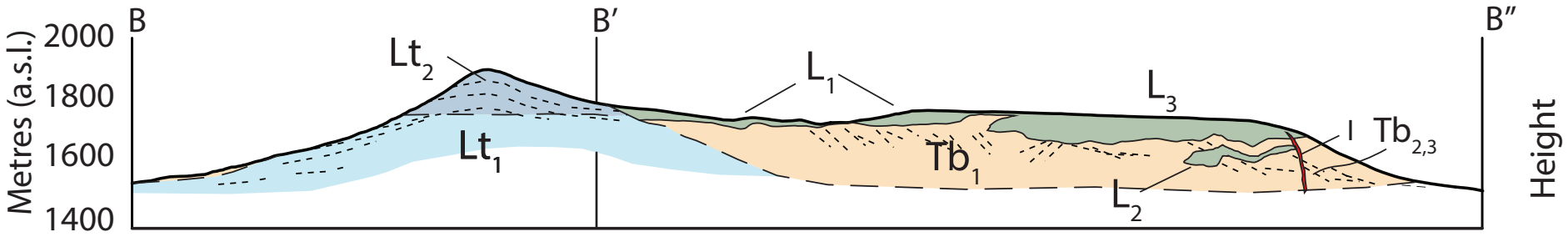
Passage Zones (2 & 3) Defined by Lava – Pillow lava Bx

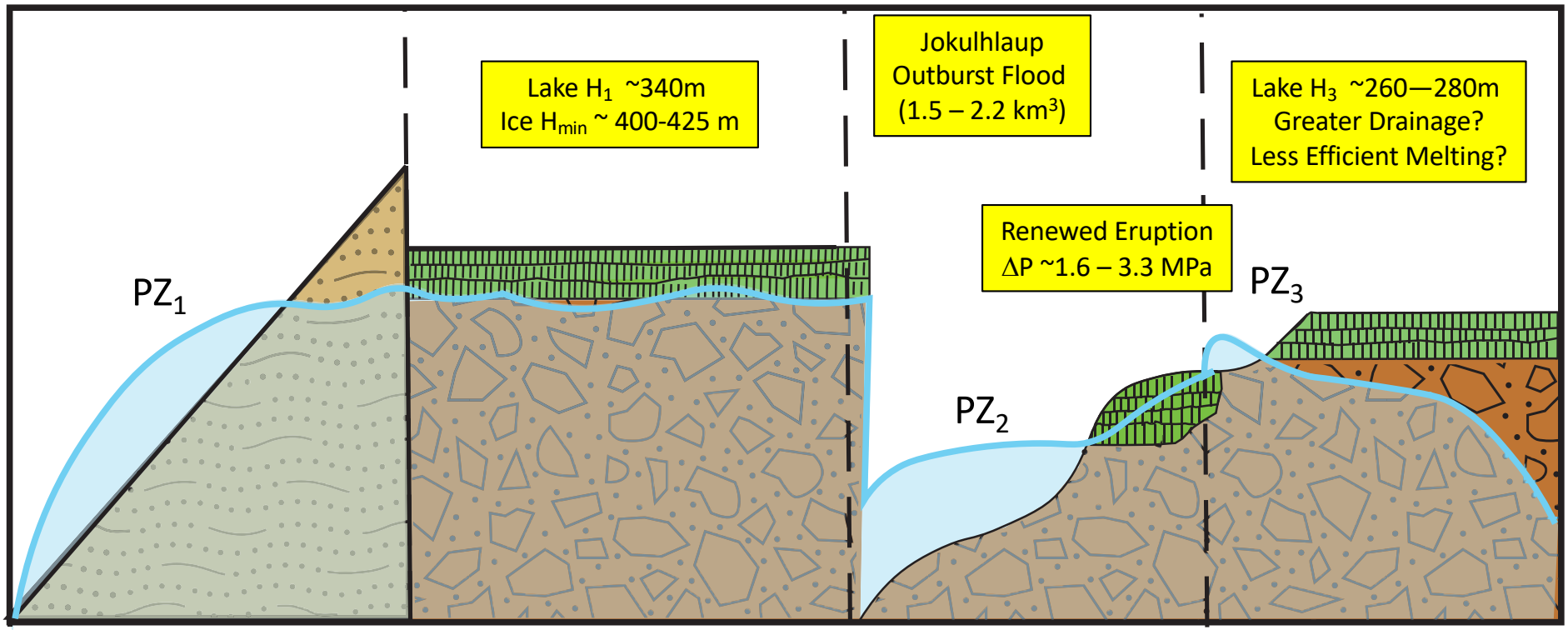


Volcano-Lake Growth & Dynamics



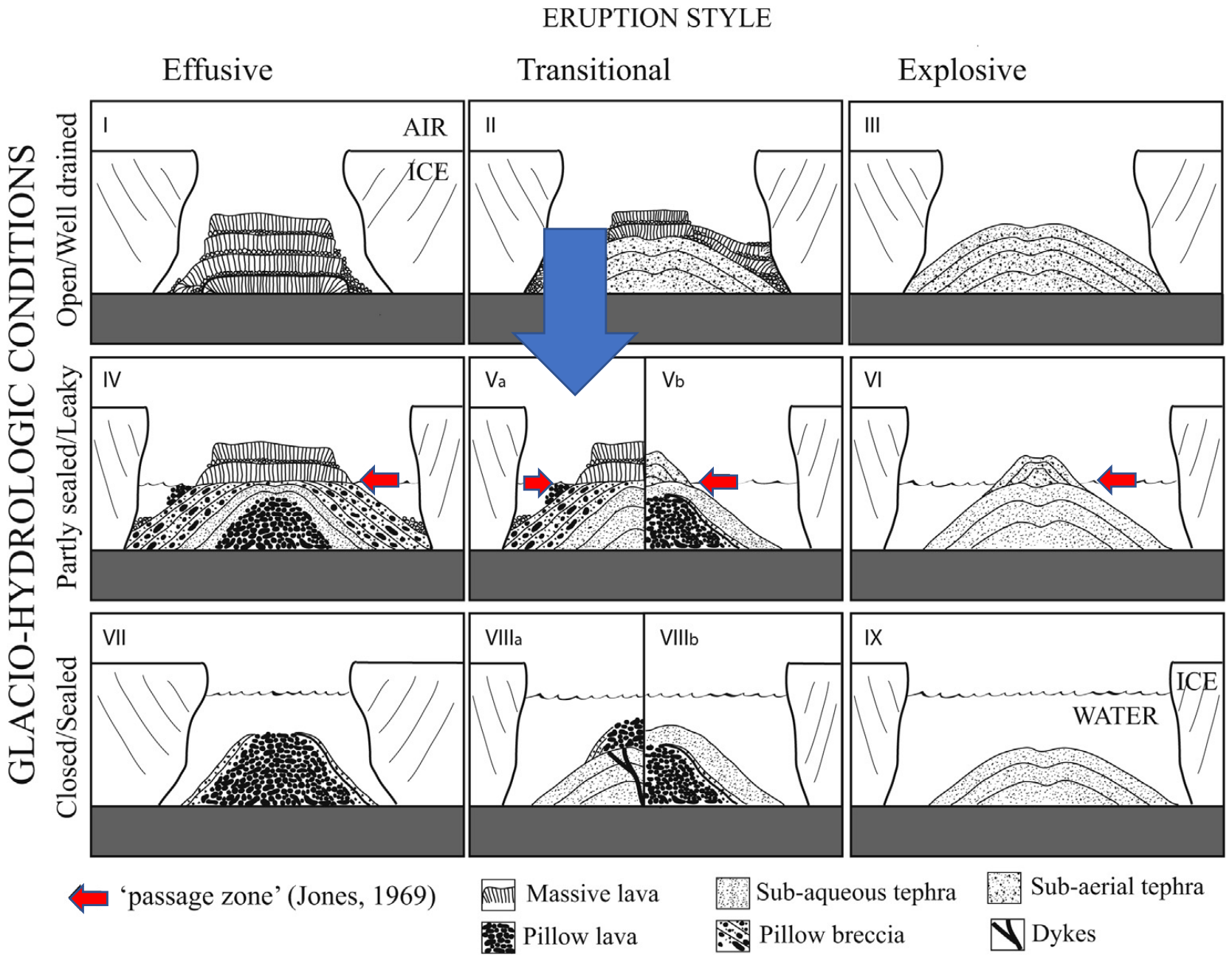
Volcano-Lake Growth & Dynamics in Paleo-CIS (1.9 Ma)





Time

Descriptive Genetic Classification of Tuyas



Russell et al. QSR, 2014

SUMMARY

- Kima Kho is a Pleistocene (1949±63 ka) tuya in the northern Canadian Cordillera
- Multiple "*passage zones*" track transient depth of syn-volcanic paleo-englacial lake
- Peak lake depth (~340m) constrains the minimum ice thickness (> 400m)
- Passage zones record a massive, catastrophic deluge (i.e. jökulhlaup) of 1-2 km^3
- Glaciovolcanism records Cordilleran-scale ice sheet at ~1.9 Ma


Thank-you