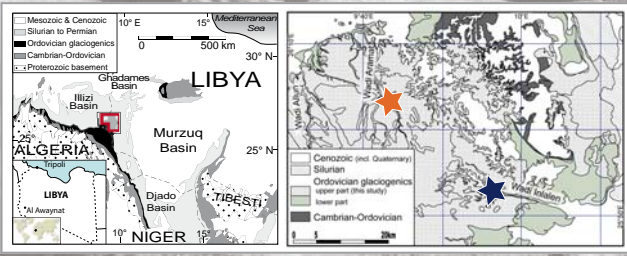


# LATE ORDOVICIAN CLIMBING DUNE ASSEMBLAGES : THE SIGNATURE OF GLACIAL OUTBURST?



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Study area

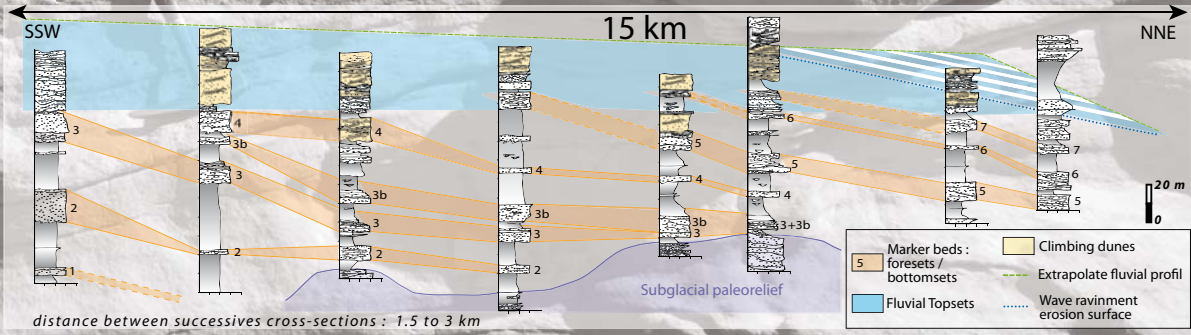
## INTRODUCTION

At the end of the Ordovician, a **continental-scale ice sheet** straddled present-day West and North Africa, as well as Arabia, possibly joining South Africa. Based on exposure data from the **Western Murzuq Basin/ Tassili n'Ajjer area** (southern Libya – Algeria boundary), this presentation aims to describe **climbing dunes assemblages** (facies, geometries and depositional model), and to relate them to outburst events affecting the fluvio-glacial outwash plains at the periphery of the retreating Late Ordovician ice sheet.

## DEPOSITIONAL SETTING

Late Ordovician sandur-type outwash plain

- **fluvio-deltaic** coarsening-upwards with a **topset/ foreset/ bottomset architecture**
- filling in glacial troughs, 5-15 km in width, separated by up to 100 m high subglacial palaeorelief forms
- fluvial topsets linked between a continental ice-front and a prograding shoreline
- climbing dune assemblages in **3 types of sand-bodies** :
  - **incised-channel bodies**
  - sandstone ribbons
  - **sandstone sheets**

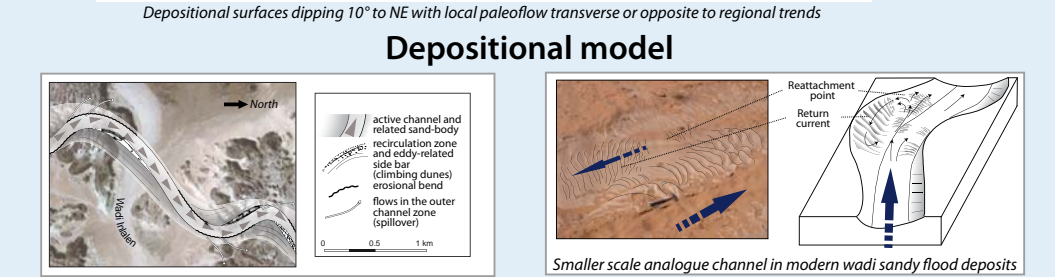
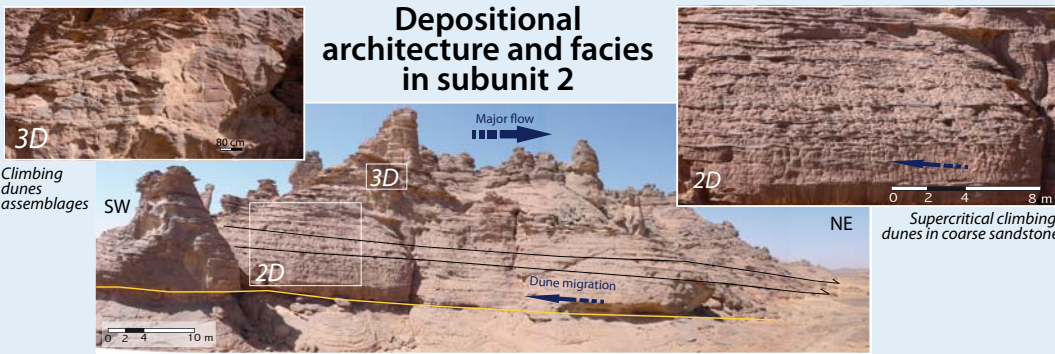
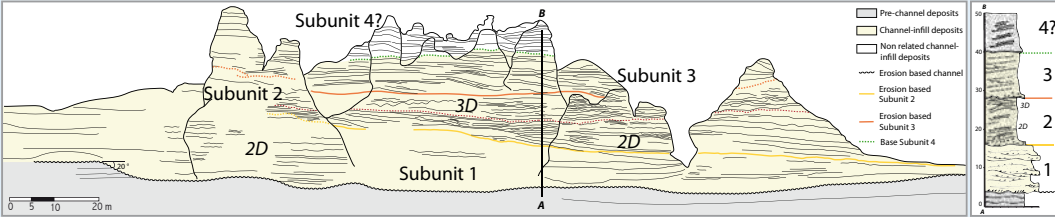


## CLIMBING DUNE ASSEMBLAGES IN AN INCISED-CHANNEL

★ **Wadi Inlalen example**

In channel erosion-based subunits

- 70 m thick, 500 m width, > 2 km long
- Finning upward succession
- Channel axis SW-NE
- 4 internal erosion-based subunits



- Steady & uniform
  - Lower regime flow conditions
  - Reverse flow conditions
  - High rates of suspended load
  - Accretion surface
- 
- Channel bends related reverse flows
  - Deposition of suspended load pumped from the channel axis
  - Transfer toward adjacent **eddy-related side bars**

## CLIMBING DUNE ASSEMBLAGES IN A SANDSTONE SHEET

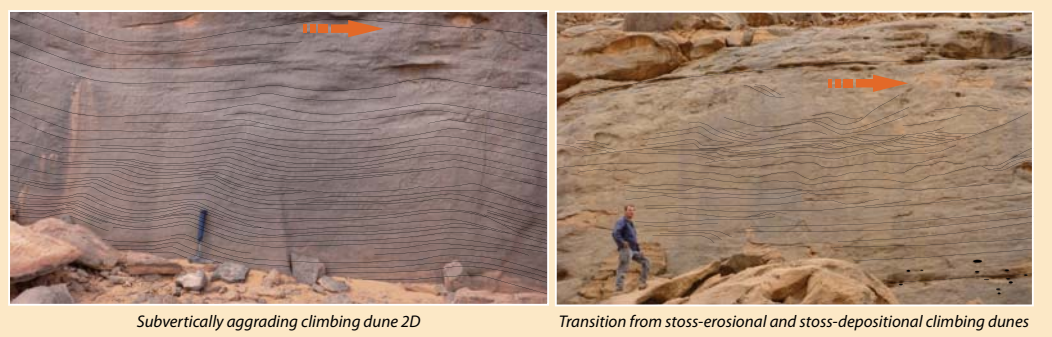
★ **Wadi Aramat & Alun example**

Sandstone sheet geometries

- 5-15 m thick, several km wide lateral extent
- m. to c. sandstones
- Basal erosion surface
- In places, accretion surfaces



## Depositional facies



## Depositional model

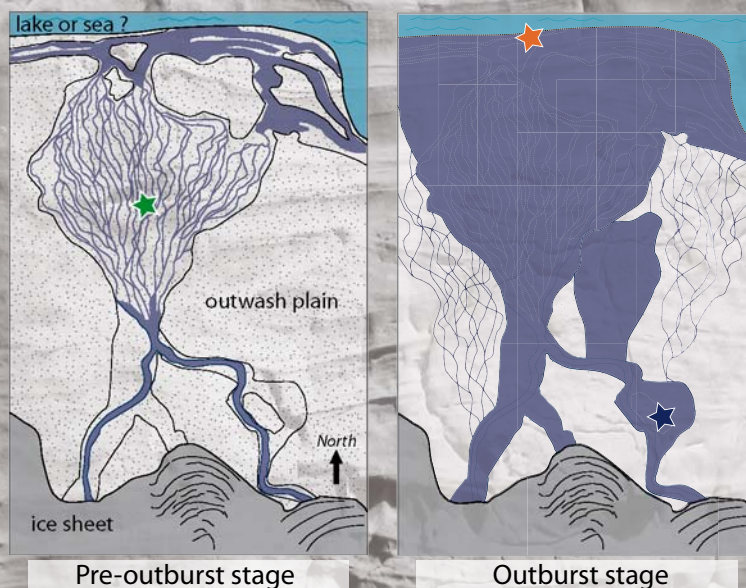
- Unconfined, turbulent, sustained flows
  - High rates of suspended load
  - Subaerial / subaquatic transition
- 
- Deposition during waning-flow conditions in **laterally extensive mouth bars**

## CLIMBING DUNES : NORMAL FLOOD OR GLACIAL OUTBURST ?

Overall depositional model : flood events corresponding to **meltwater outbursts** that have periodically transferred great quantities of sand from the eroding, subglacial environment to the depositional, **proglacial outwash plain**.

## Land system

- ★ **Proximal zone** : few deep and narrow **incised channels** forming a subaerial extension of the subglacial drainage network, climbing dune assemblages in **eddy-related side bars**
- ★ **Intermediate zone** : complex network of shallow channels
- ★ **Distal zone** : **unconfined flow** entering the water body, climbing dune assemblages in **laterally extensive mouth bars**



## Specificities of late Ordovician outburst

- **Catastrophic** subglacial drainage events
- Glacial record **dominated by sand**
- **Great quantities of sand** (~1600 x 10<sup>6</sup> tons) transferred from tunnel valley systems toward the proglacial outwash plains
- **Duration of a couple of days** for a single flood event as jökulhlaups events