Tibet, a training facility and analogue of the Holden Crater landing site

Third Mars 2020 Landing Site Workshop
Pasadena: February 8-10, 2017

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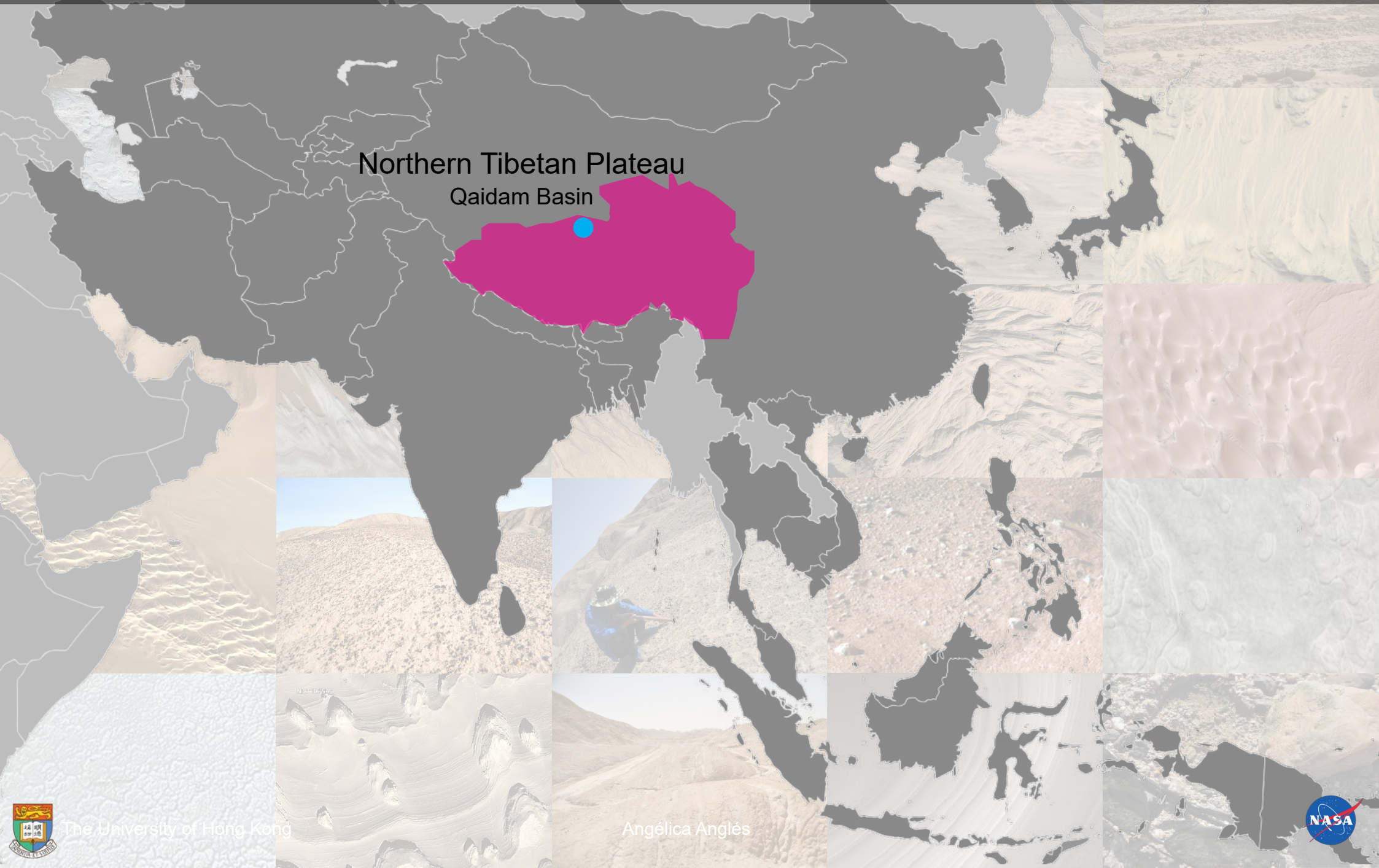
Qaidam Basin - Analogue Site



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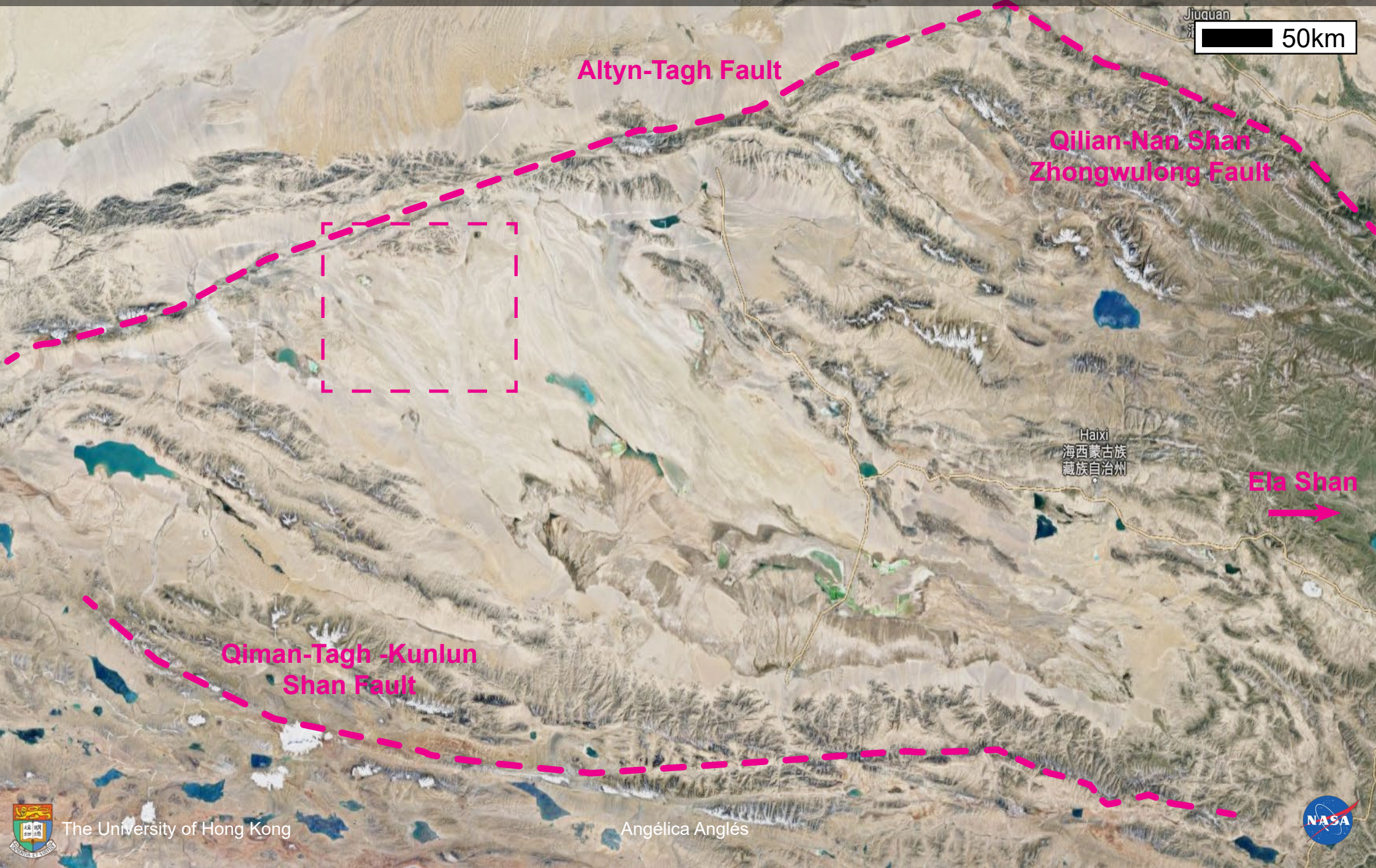
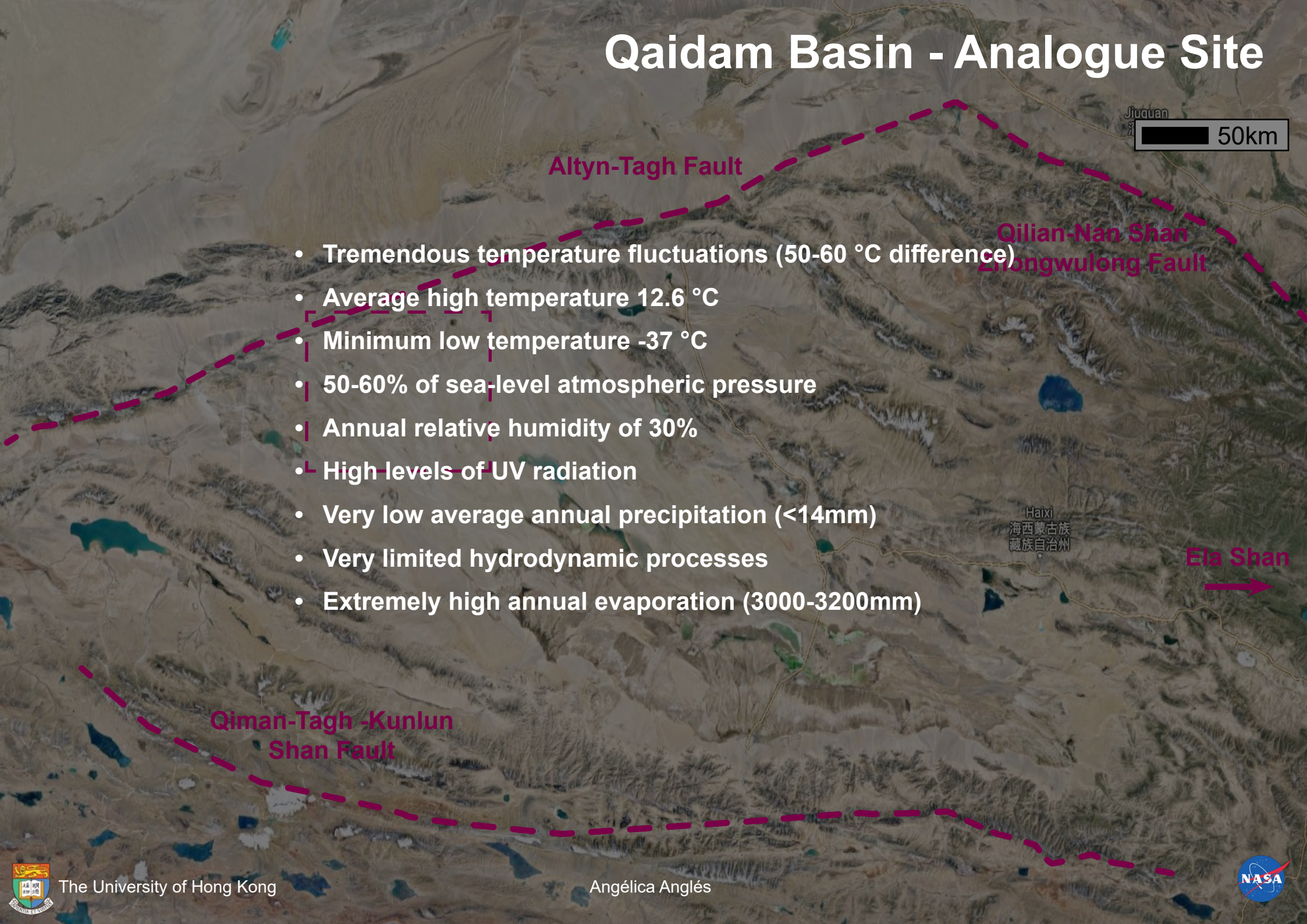
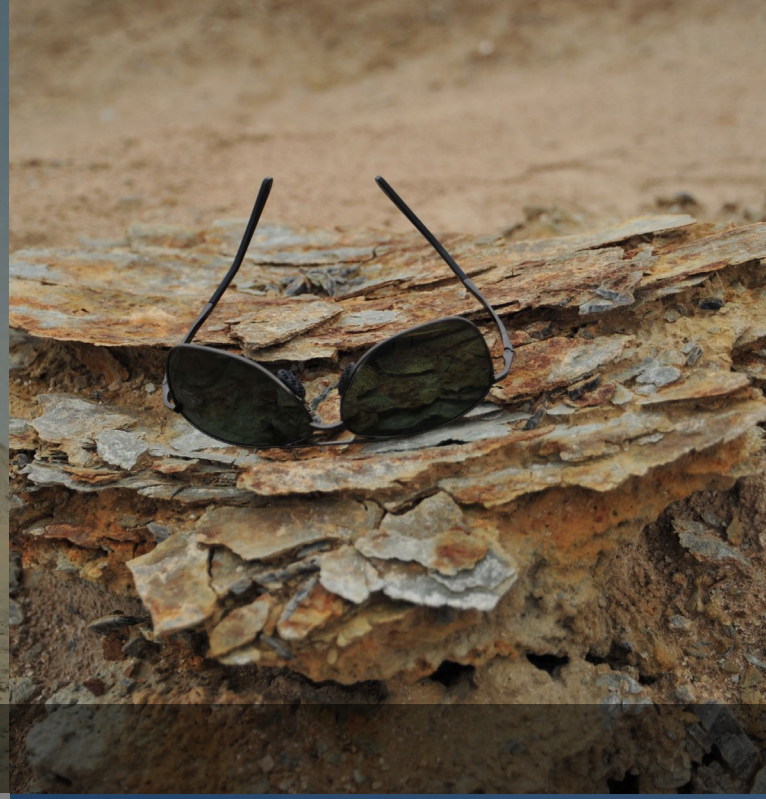
Qaidam Basin - Analogue Site



Qaidam Basin - Analogue Site



- Tremendous temperature fluctuations (50-60 °C difference)
- Average high temperature 12.6 °C
- Minimum low temperature -37 °C
- 50-60% of sea-level atmospheric pressure
- Annual relative humidity of 30%
- High levels of UV radiation
- Very low average annual precipitation (<14mm)
- Very limited hydrodynamic processes
- Extremely high annual evaporation (3000-3200mm)



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Evaporite minerals	
gypsum	$CaSO_4 \cdot 2H_2O$
halite	$NaCl$
polyhalite	$K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$
anhydrite	$CaSO_4$
pentahydrite	$MgSO_4 5H_2O$
sanderite	$MgSO_4 2H_2O$
thenardite	Na_2SO_4
epsomite	$MgSO_4 7H_2O$
glauberite	$Na_2Ca(SO_4)_2$
kainite	$KMg(SO_4)Cl3H_2O$
blodite	$Na_2Mg(SO_4)_2 4H_2O$
meridianiite	$MgSO_4 11H_2O$
hexahydrite	$MgSO_4 6H_2O$
pentahydrite	$MgSO_4 5H_2O$
starkeyite	$MgSO_4 4H_2O$
mirabilite	$Na_2SO_4 10H_2O$
kieserite	$MgSO_4 1H_2O$

Phyllosilicates	
illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$
montmorillonite	$(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2nH_2O$
muscovite	$KAl_2(AlSi_3O_{10})(F,OH)_2$
clinochlore	$(Mg_5Al)(AlSi_3)O_{10}(OH)_8$
glauconite	$(K,Na)(Fe^{3+},Al,Mg)_2(Si,Al)4O_{10}(OH)_2$
quartz	SiO_2

Carbonates	
aragonite	$CaCO_3$
calcite	$CaCO_3$
dolomite	$CaMg(CO_3)_2$

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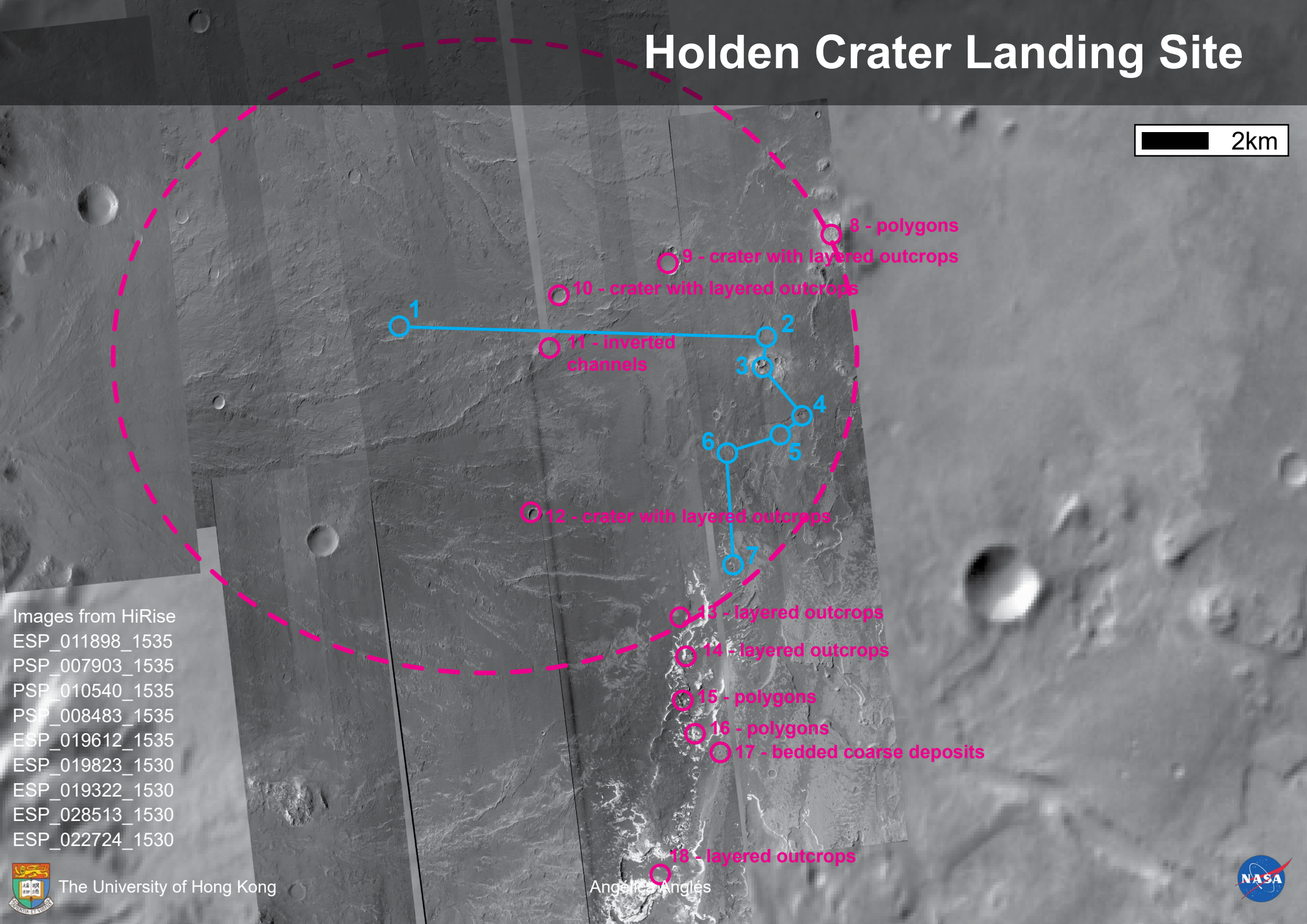
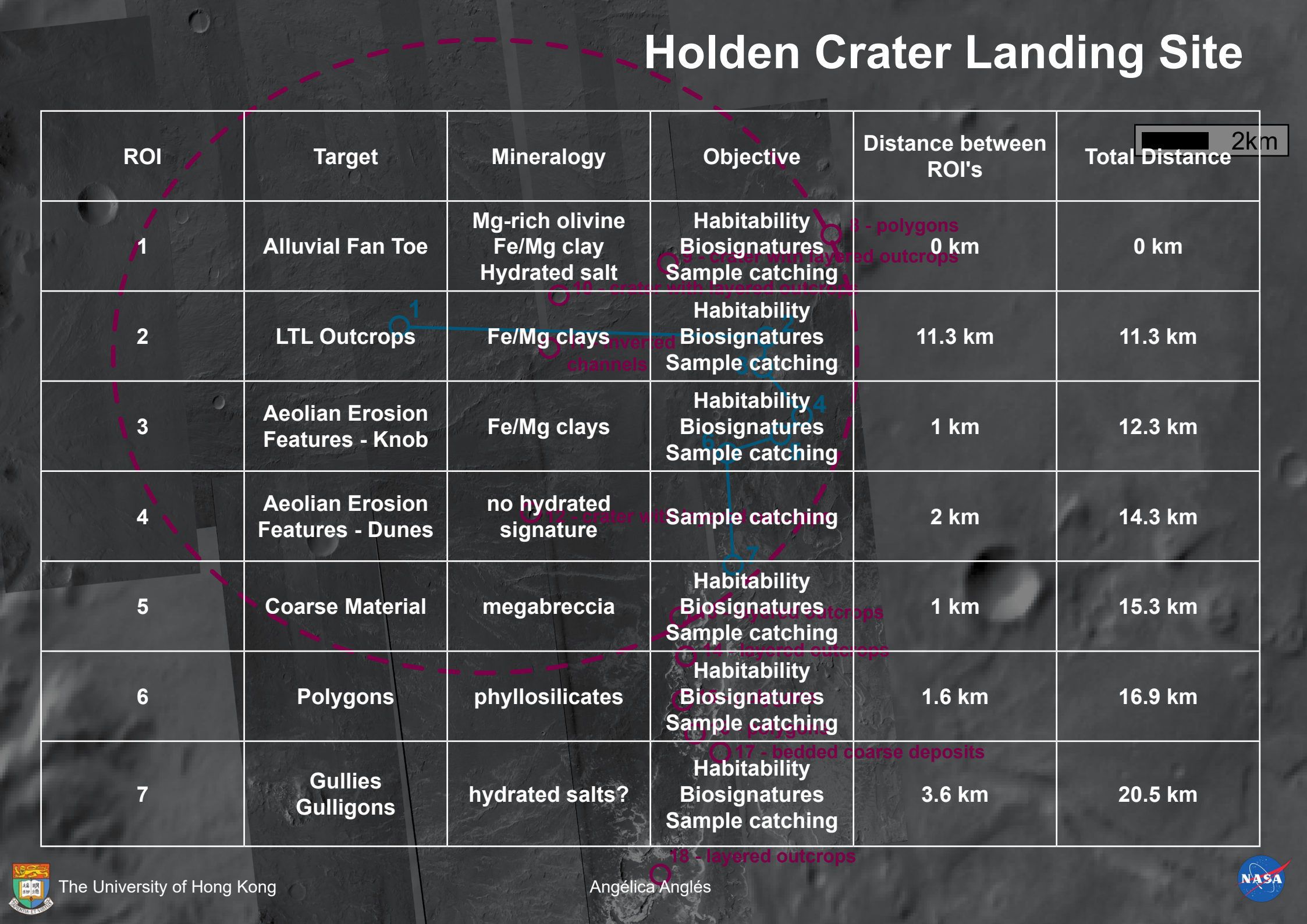
Holden Crater Landing Site

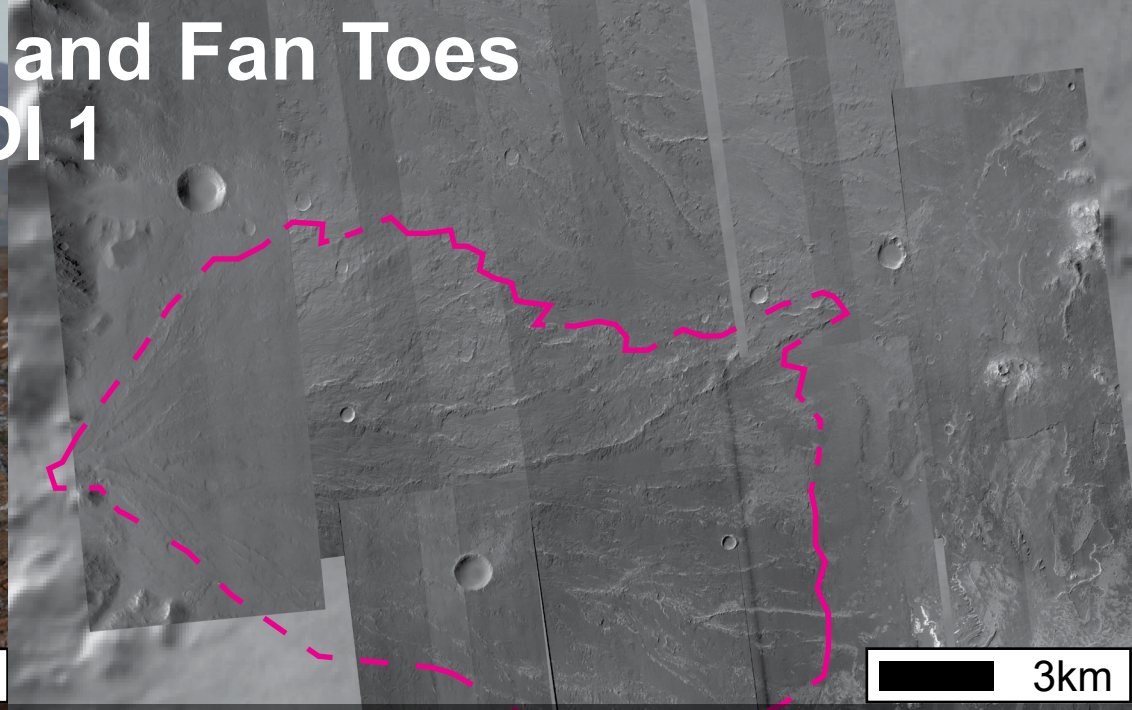


Holden Crater Landing Site

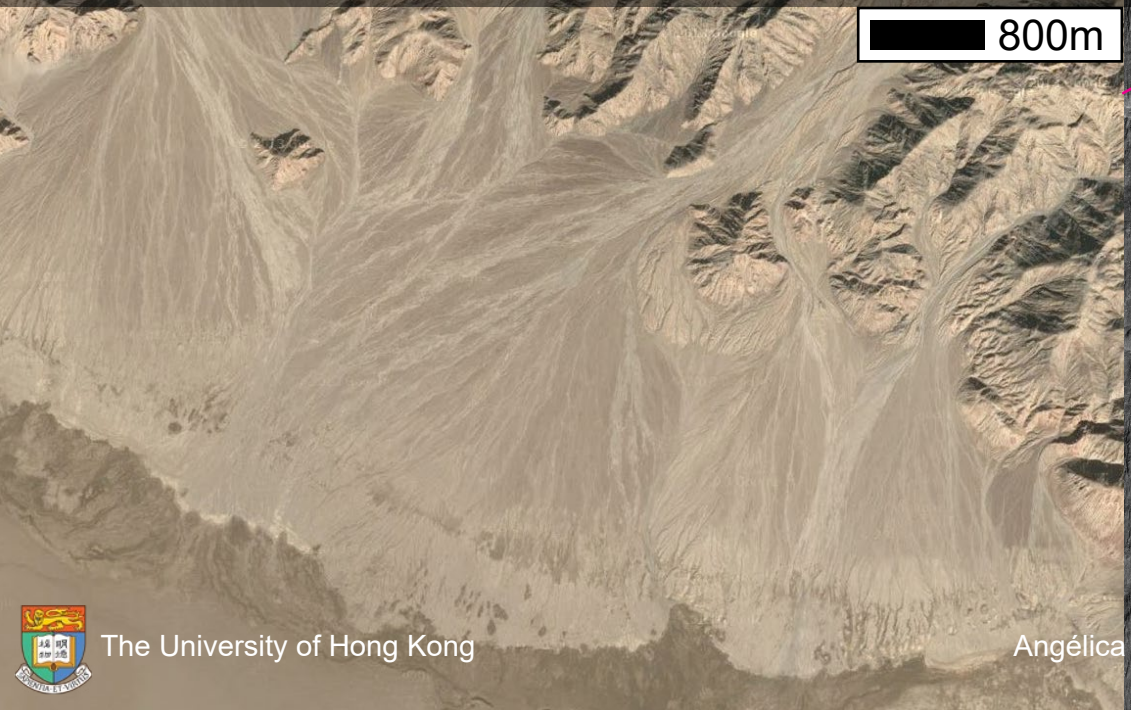
ROI	Target	Mineralogy	Objective	Distance between ROI's	Total Distance
1	Alluvial Fan Toe	Mg-rich olivine Fe/Mg clay Hydrated salt	Habitability Biosignatures Sample catching	0 km	0 km
2	LTL Outcrops	Fe/Mg clays	Habitability Biosignatures Sample catching	11.3 km	11.3 km
3	Aeolian Erosion Features - Knob	Fe/Mg clays	Habitability Biosignatures Sample catching	1 km	12.3 km
4	Aeolian Erosion Features - Dunes	no hydrated signature	Sample catching	2 km	14.3 km
5	Coarse Material	megabreccia	Habitability Biosignatures Sample catching	1 km	15.3 km
6	Polygons	phyllosilicates	Habitability Biosignatures Sample catching	1.6 km	16.9 km
7	Gullies Gulligons	hydrated salts?	Habitability Biosignatures Sample catching	3.6 km	20.5 km



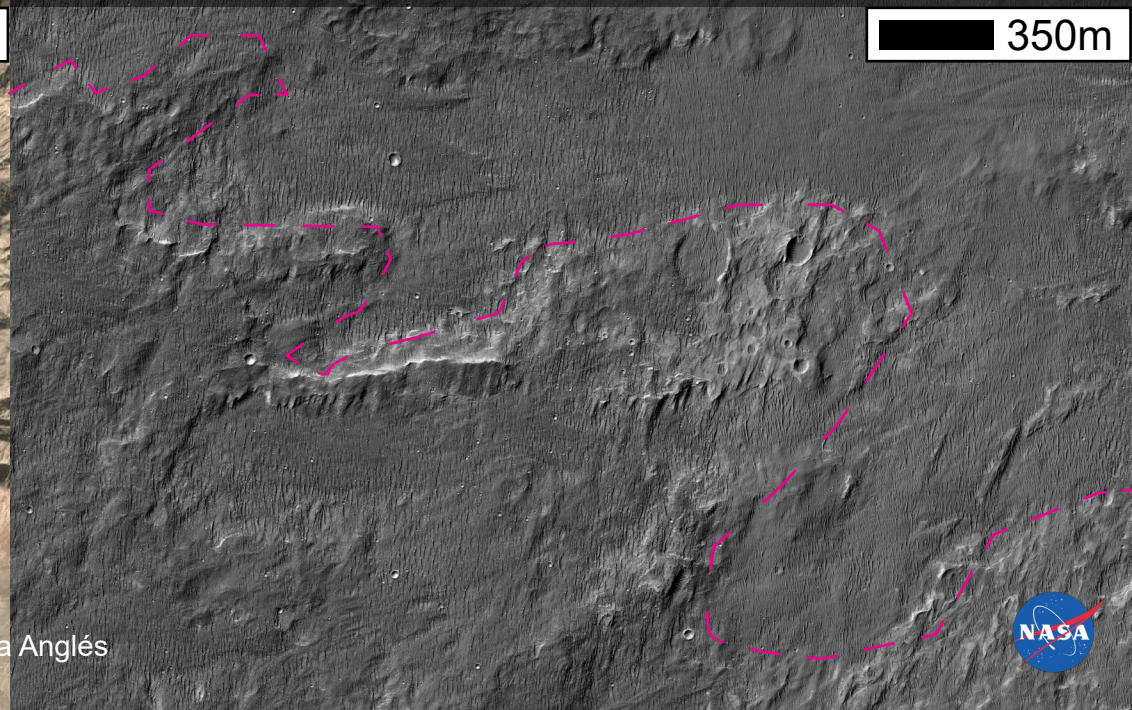
Alluvial Fans and Fan Toes
ROI 1



Qaidam Basin



Holden Crater



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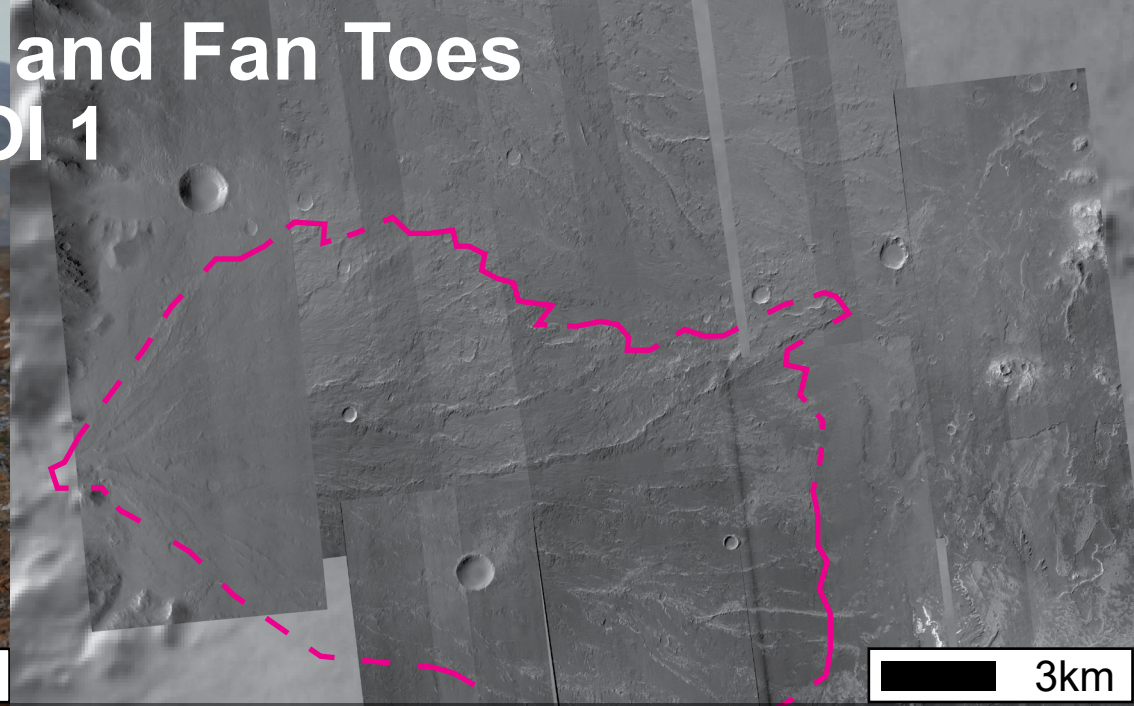
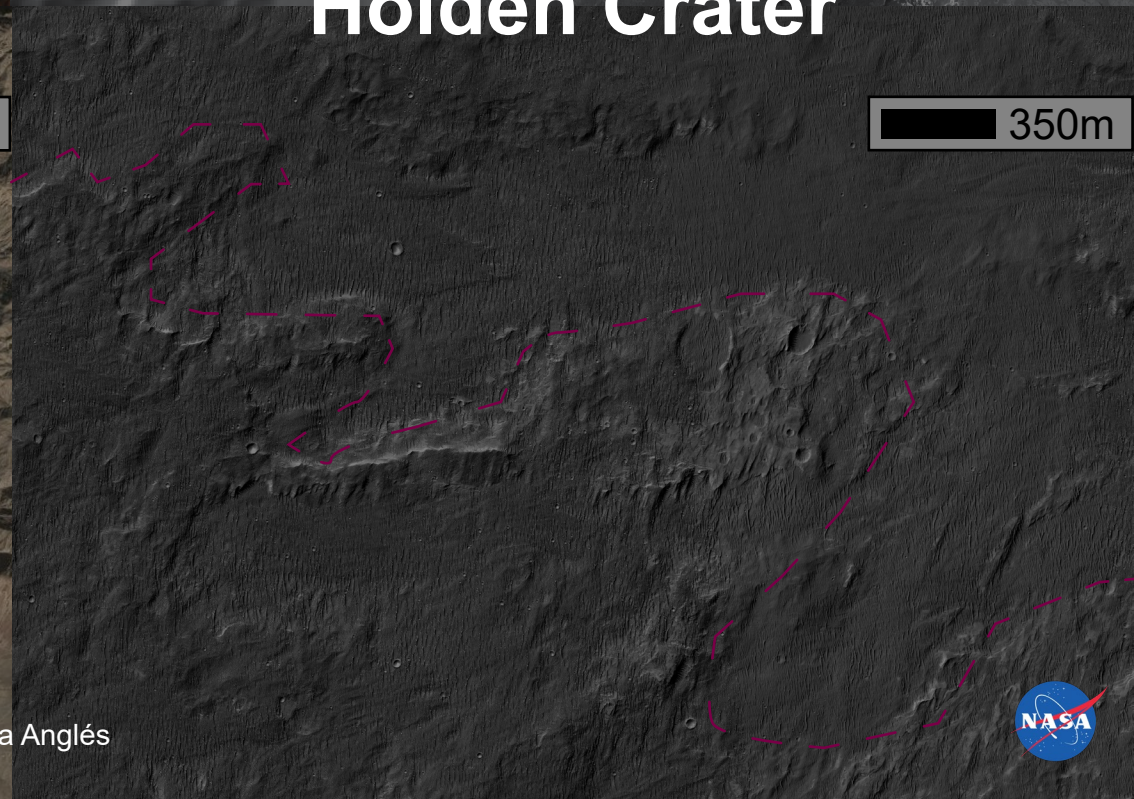
Alluvial Fans and Fan Toes
ROI 1



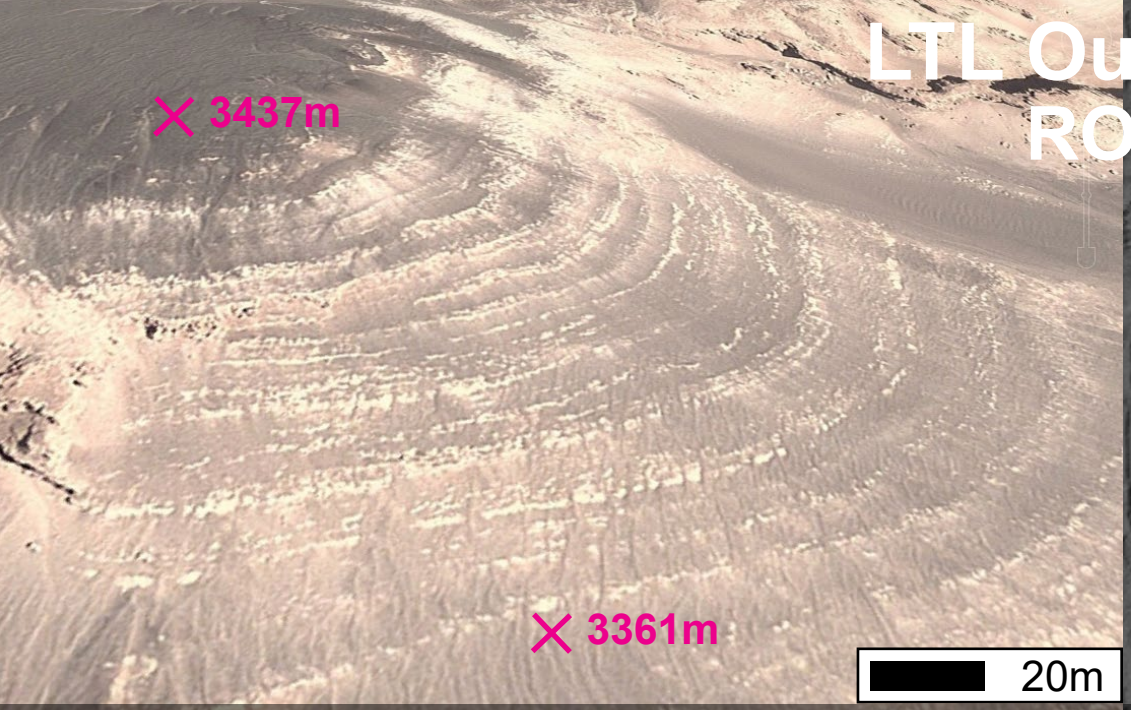
Qaidam Basin

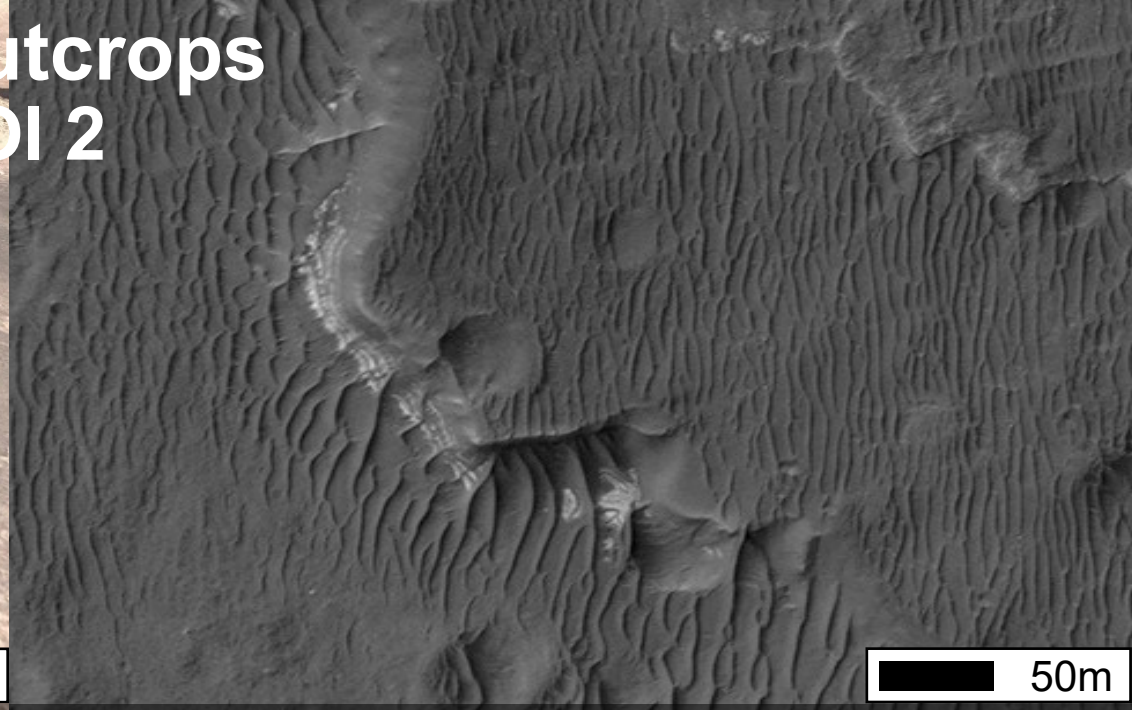
Holden Crater



- mineralogy
- source of water
- bedrock properties
- original landforms
- local climate
- later modification processes

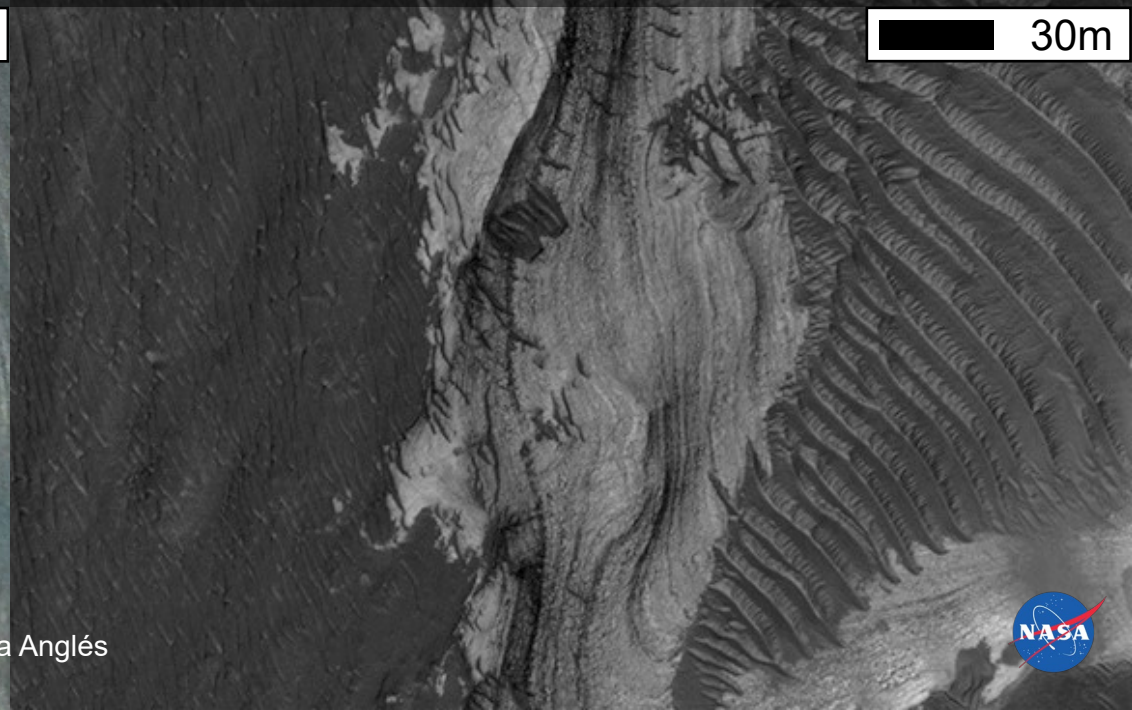
LTL Outcrops
ROI 2



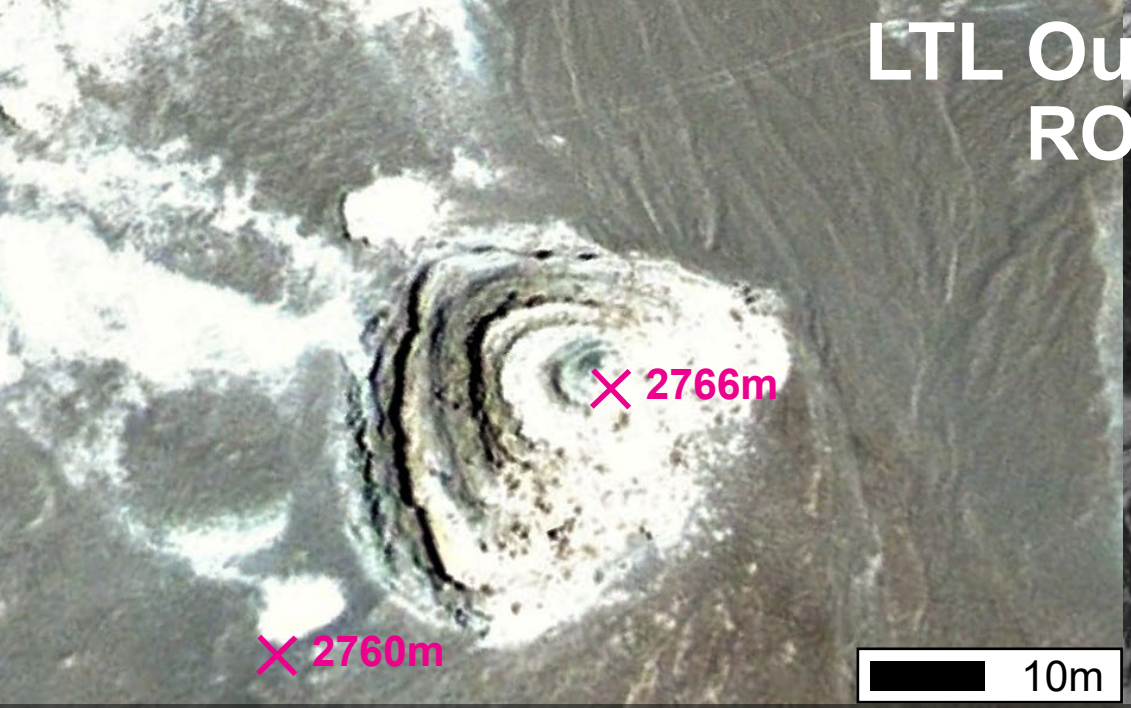


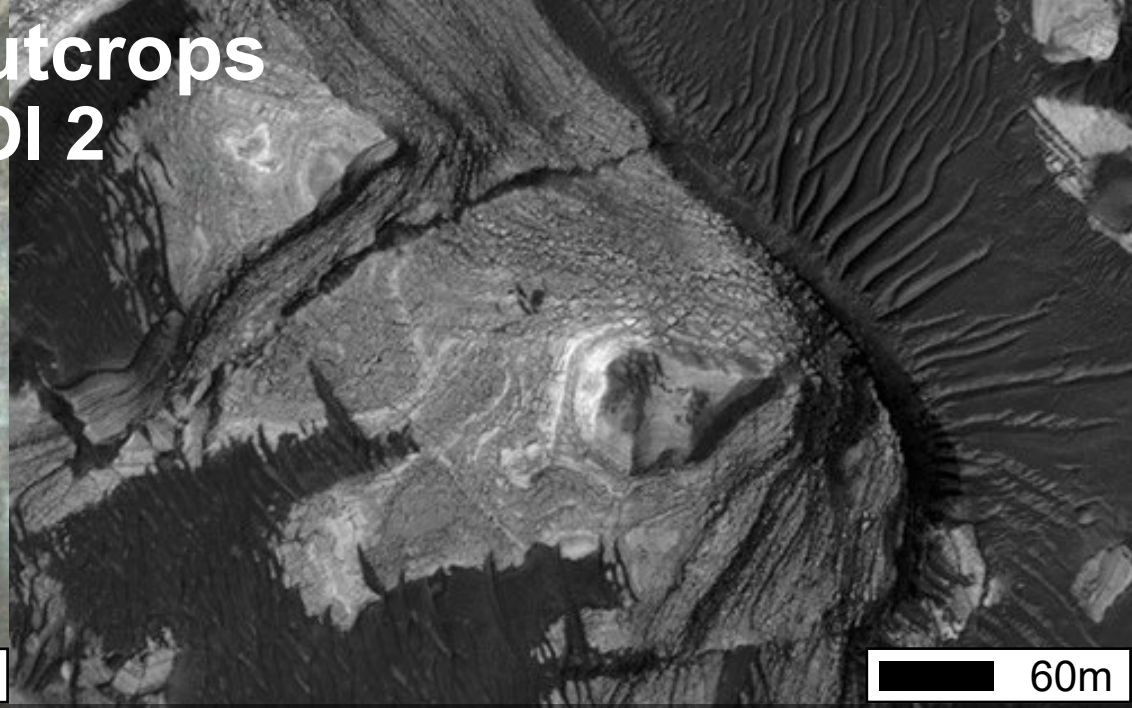
Qaidam Basin

Holden Crater



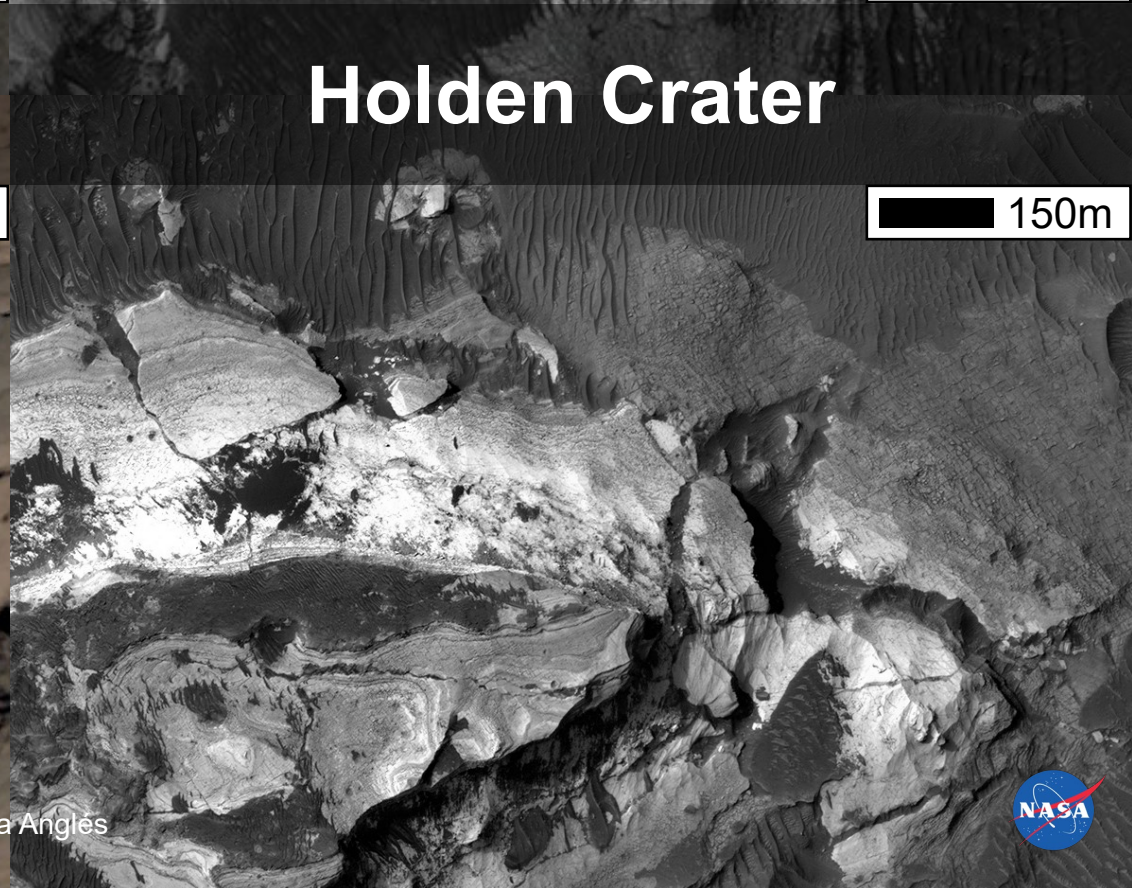
LTL Outcrops
ROI 2



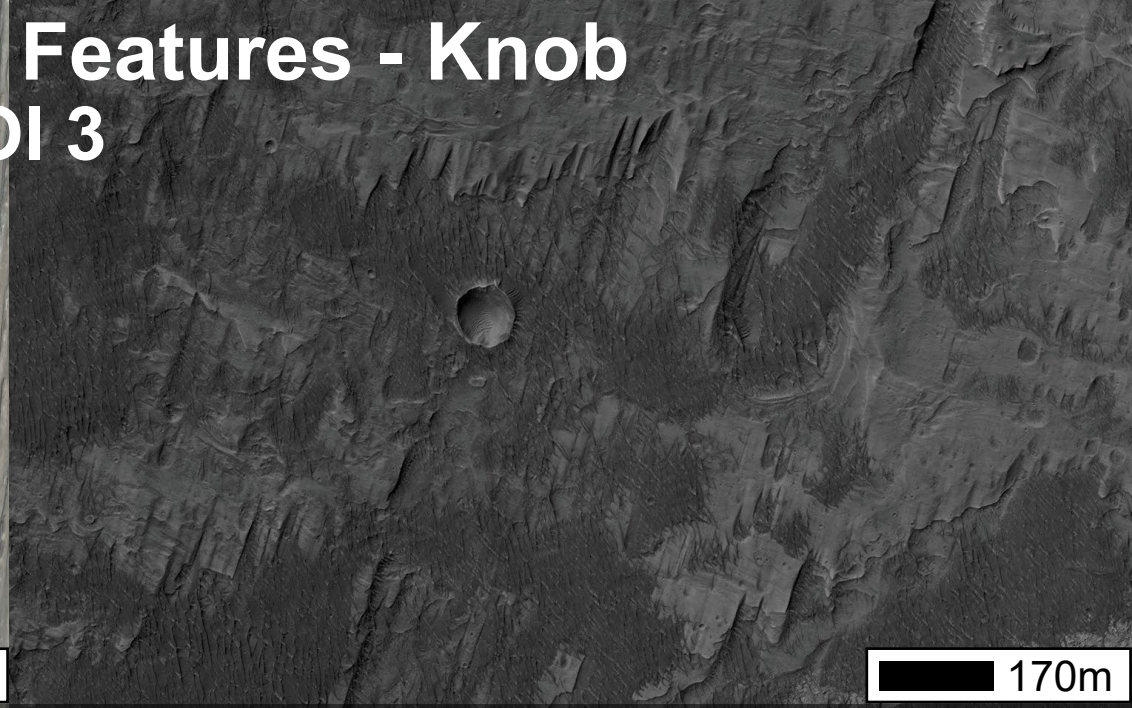


Qaidam Basin

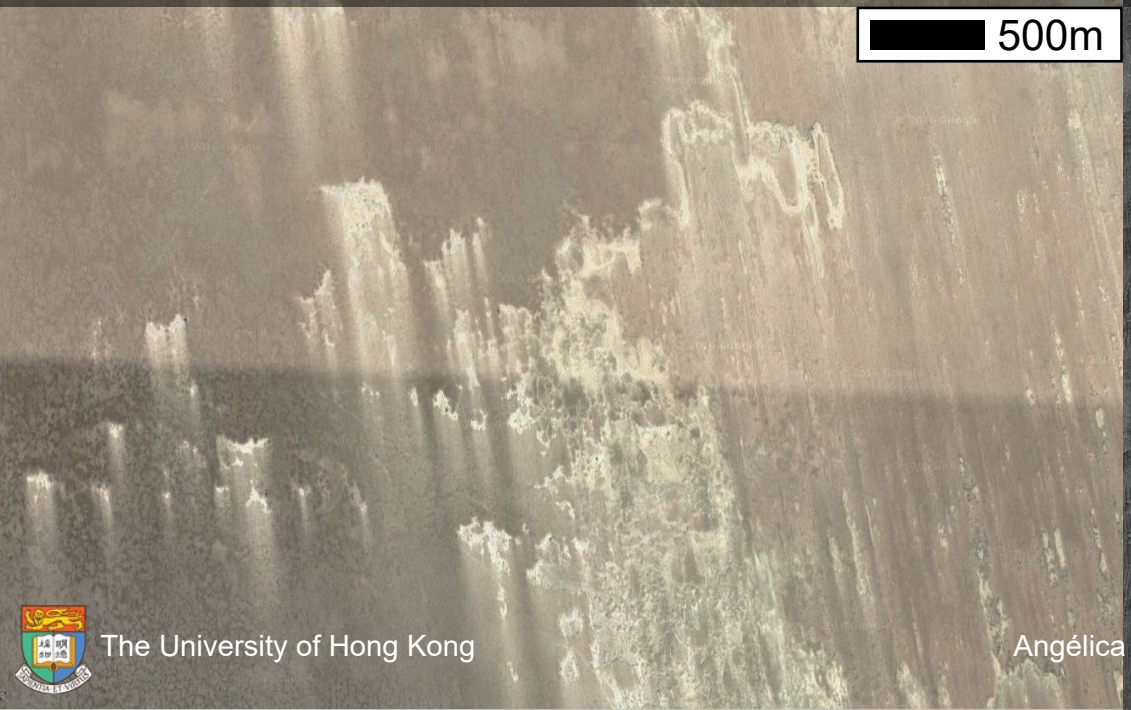
Holden Crater



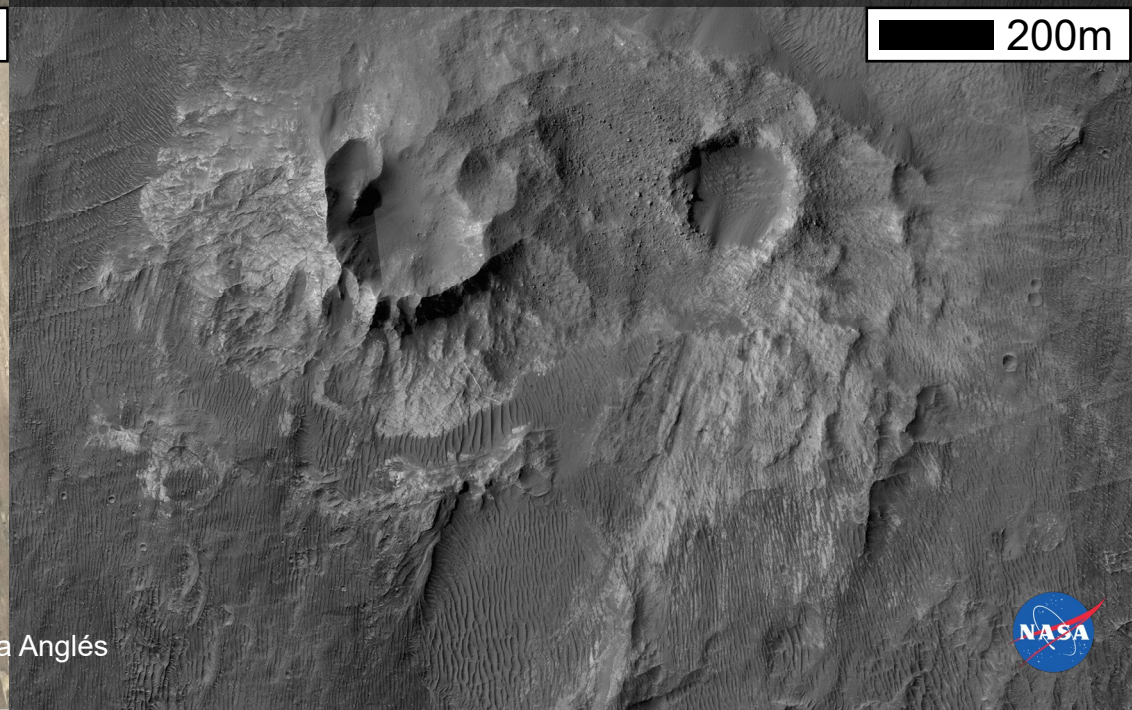
Aeolian Erosion Features - Knob
ROI 3



Qaidam Basin



Holden Crater



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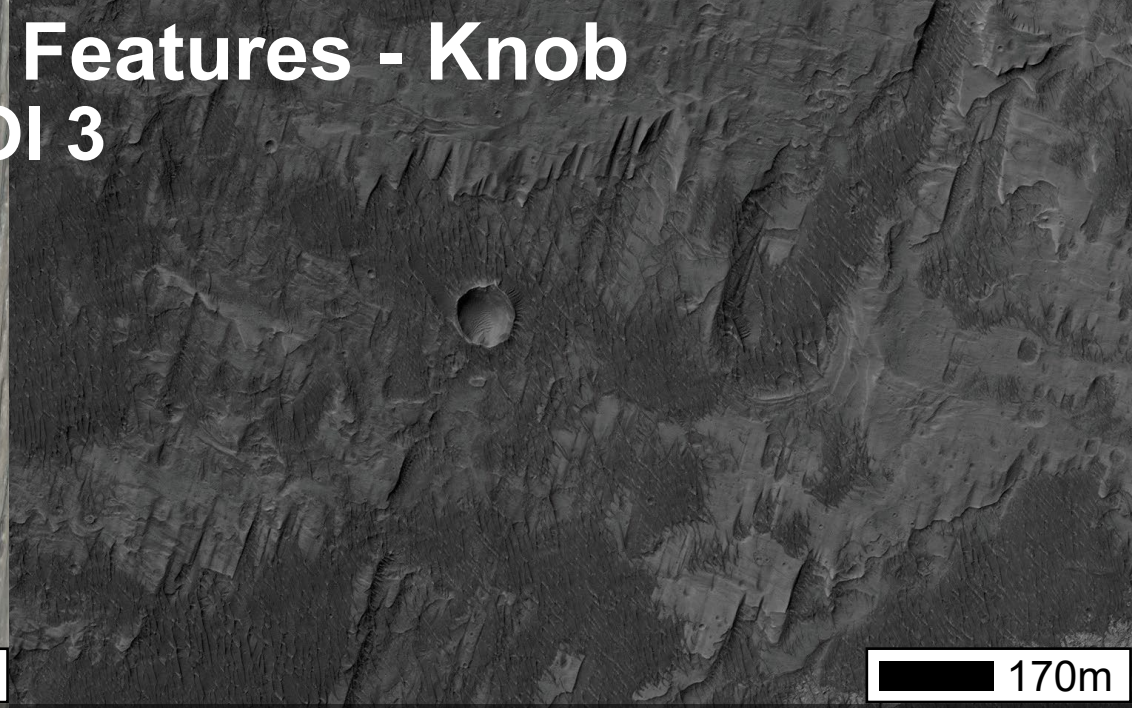
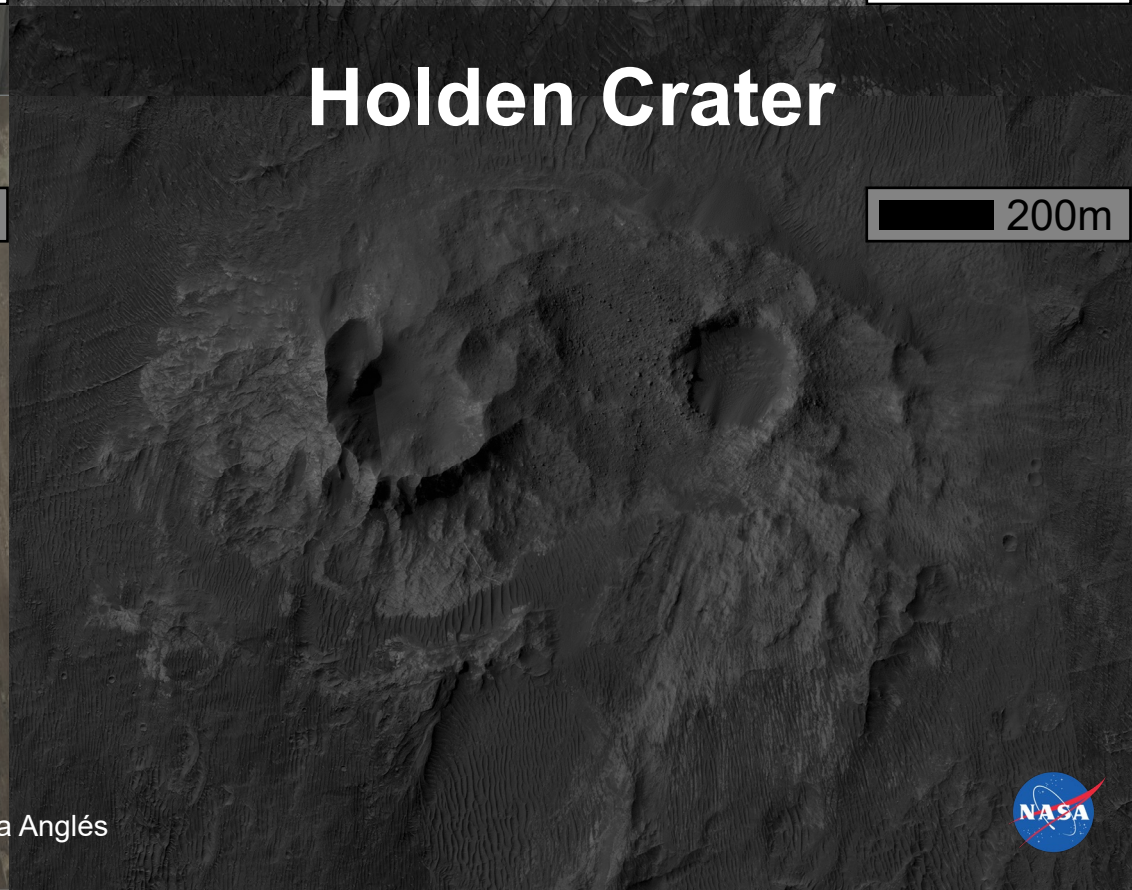
Aeolian Erosion Features - Knob
ROI 3



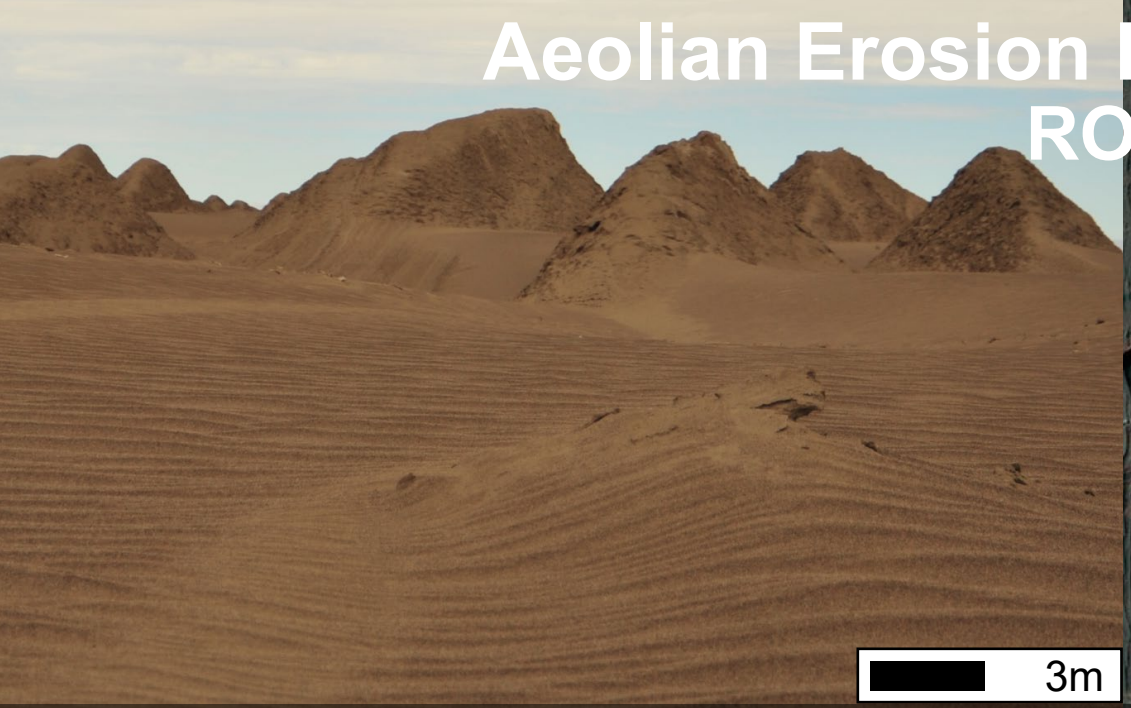
Qaidam Basin

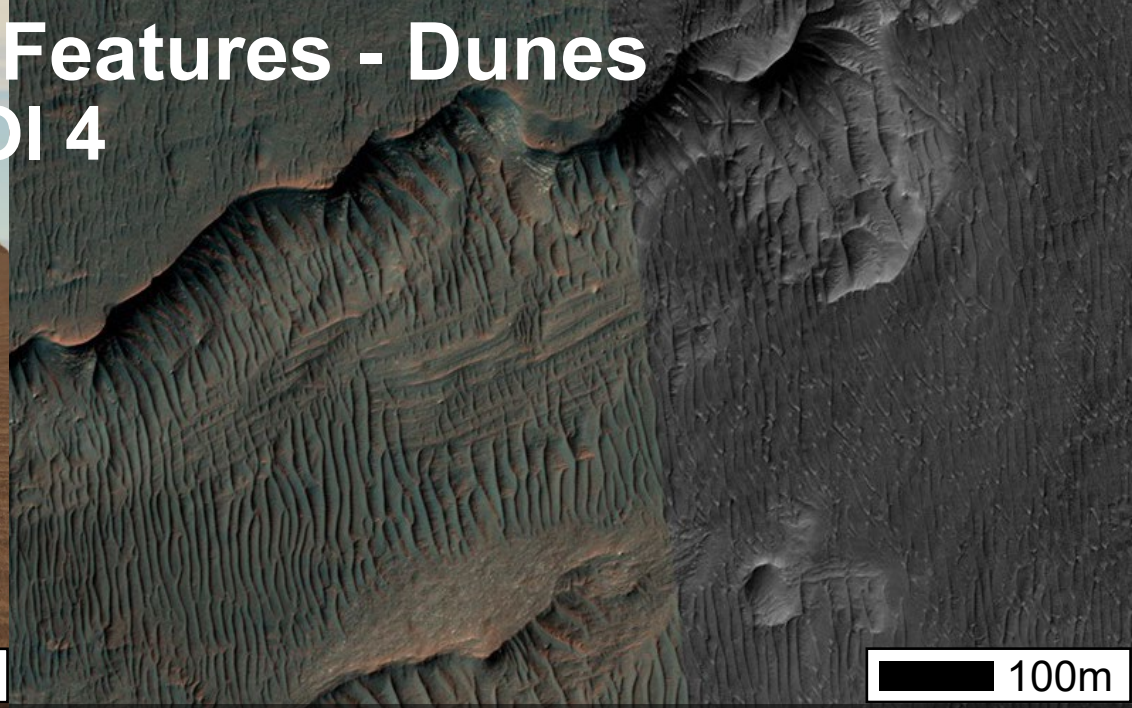
- quartz
- gypsum
- halite
- chlinochlore
- sanderite
- muscovite
- thenardite

Holden Crater

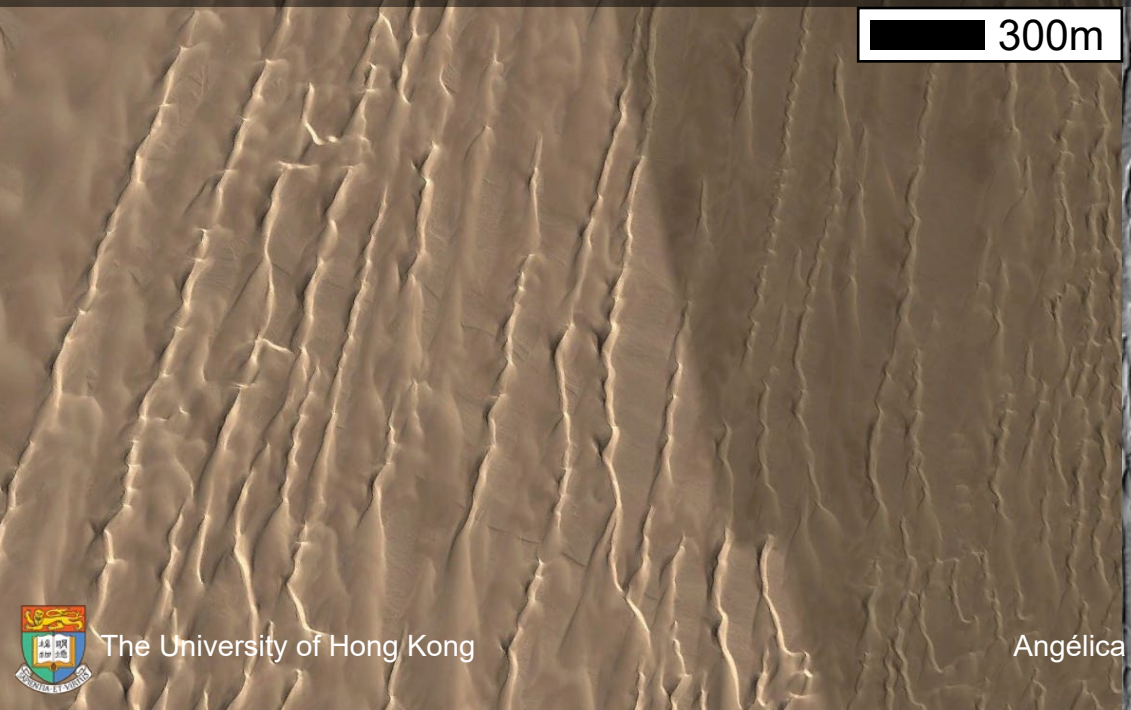


Aeolian Erosion Features - Dunes
ROI 4

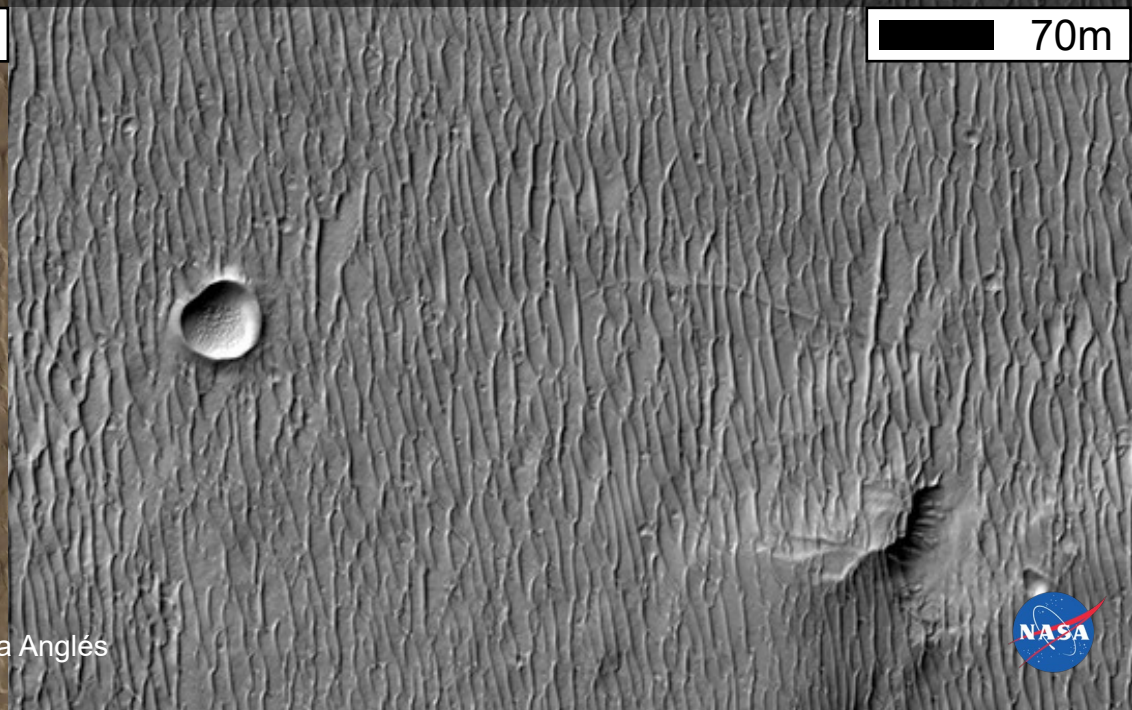




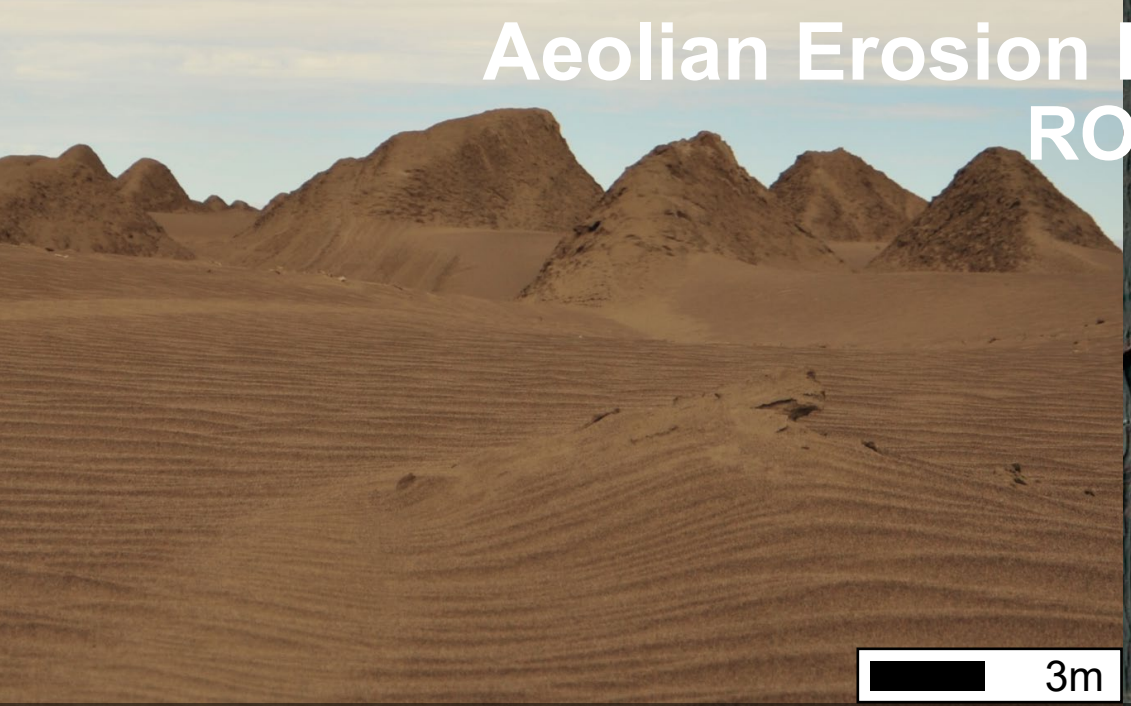
Qaidam Basin

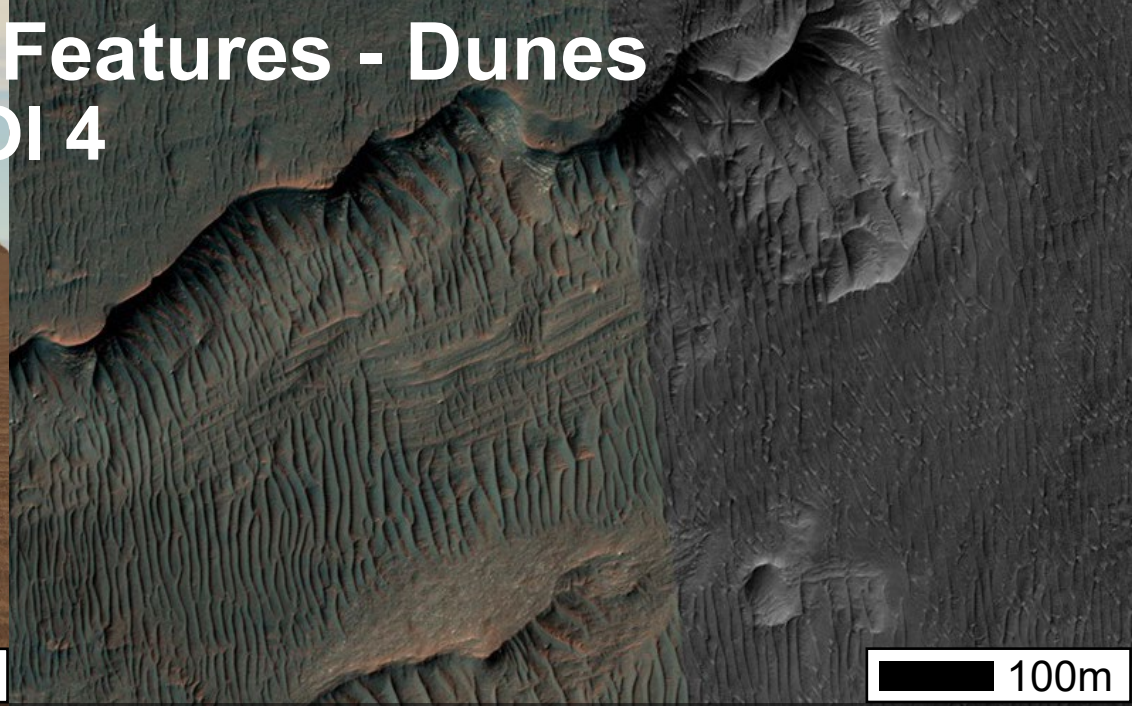


Holden Crater

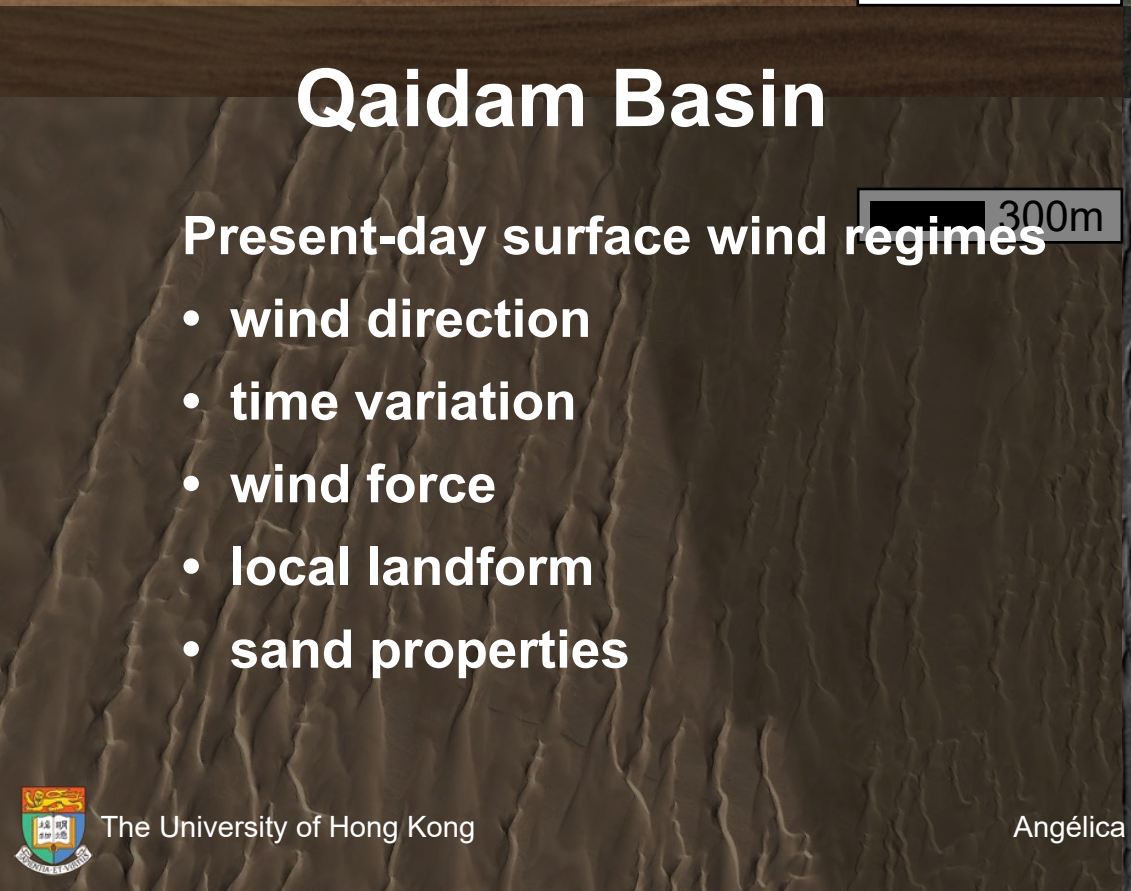


Aeolian Erosion Features - Dunes
ROI 4





Qaidam Basin



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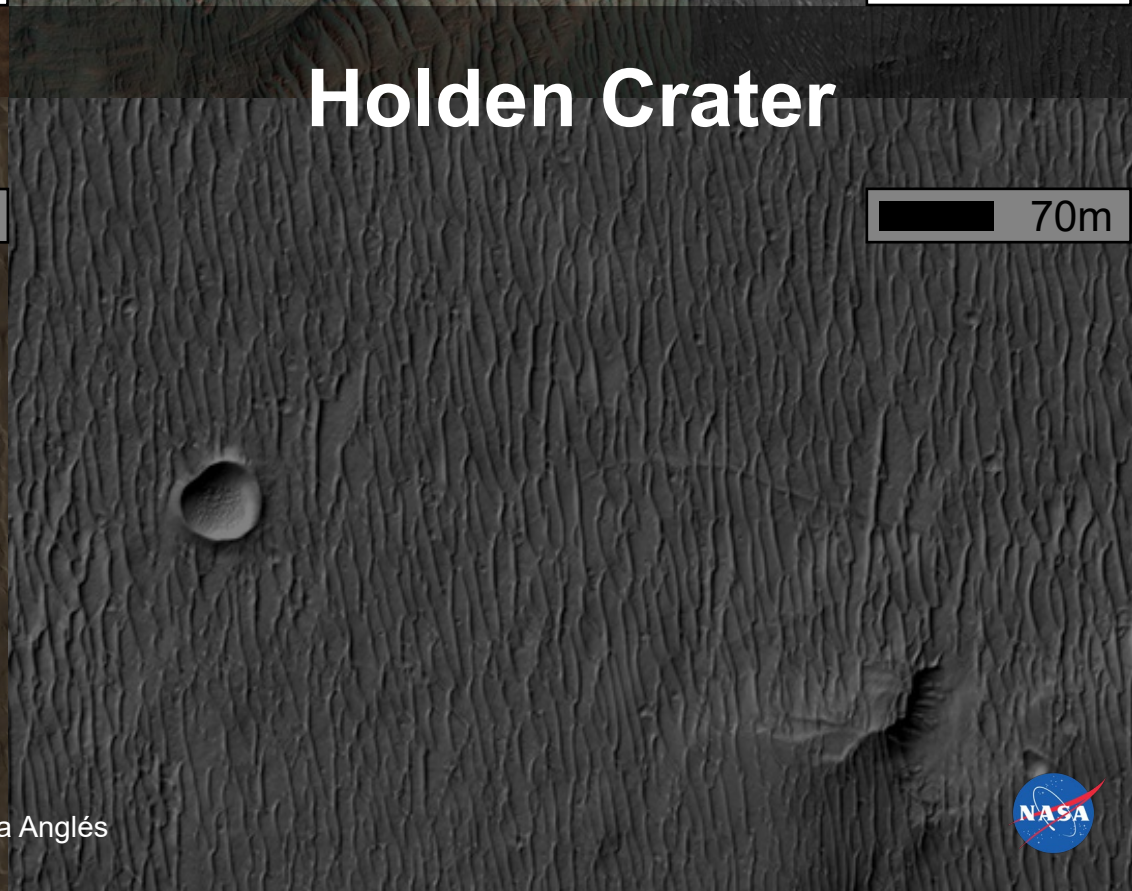
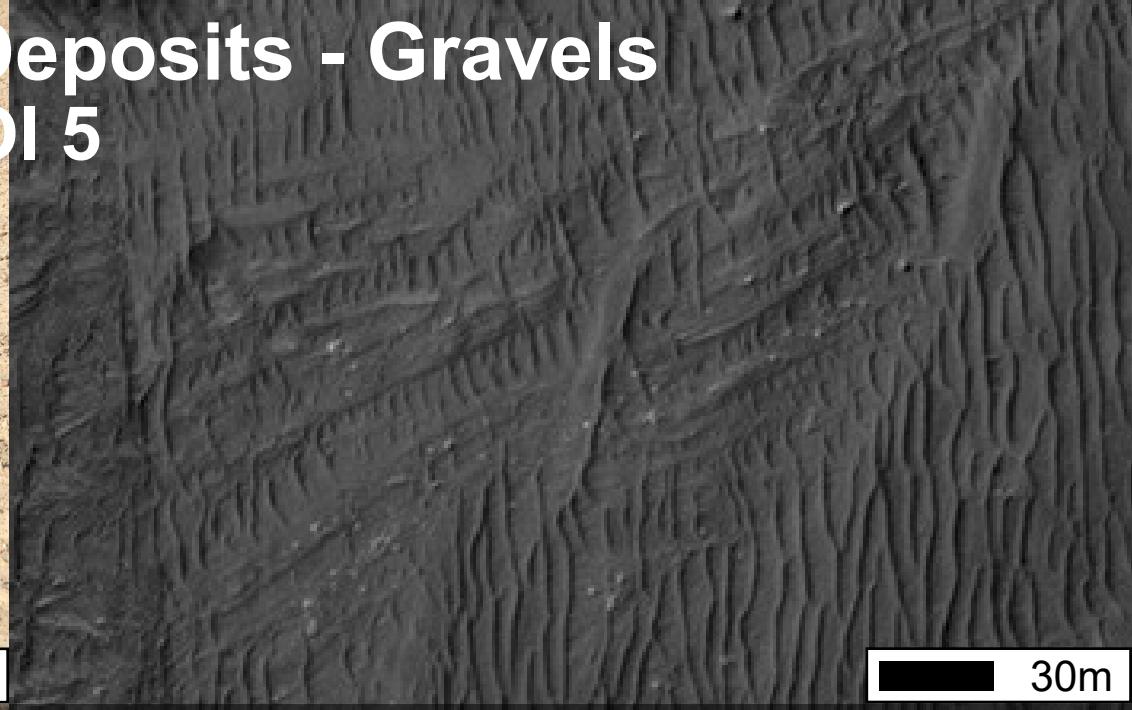


Present-day surface wind regimes

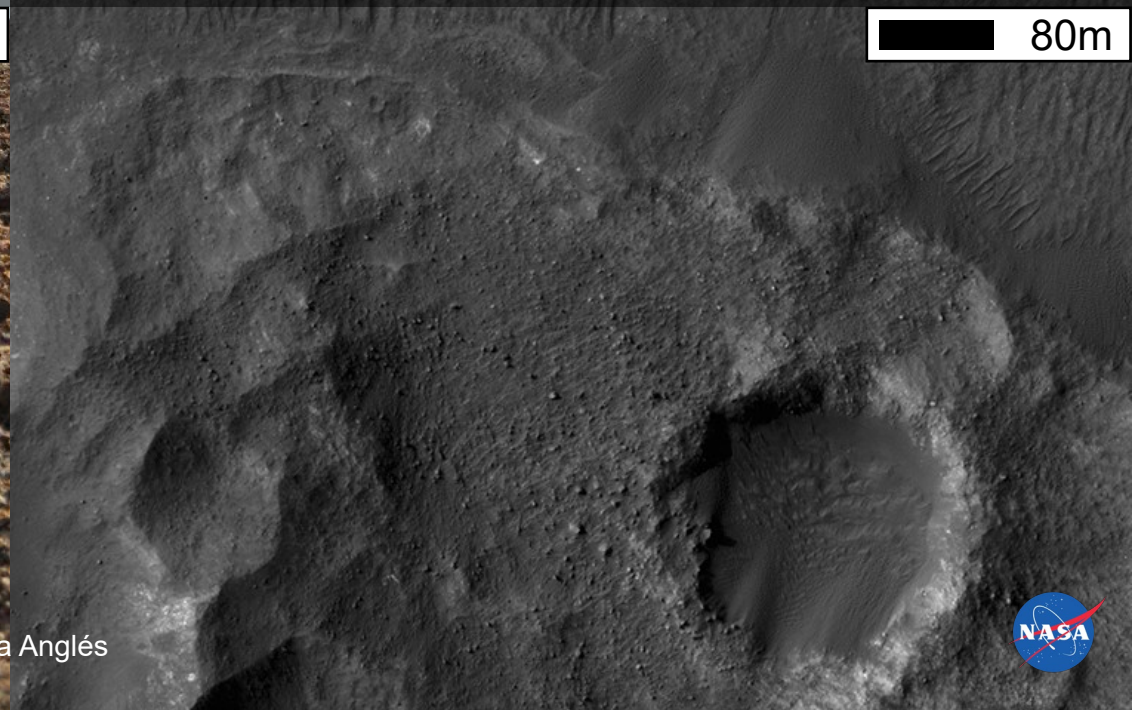
- **wind direction**
- **time variation**
- **wind force**
- **local landform**
- **sand properties**

Coarse Bedded Deposits - Gravels
ROI 5



Qaidam Basin

Holden Crater



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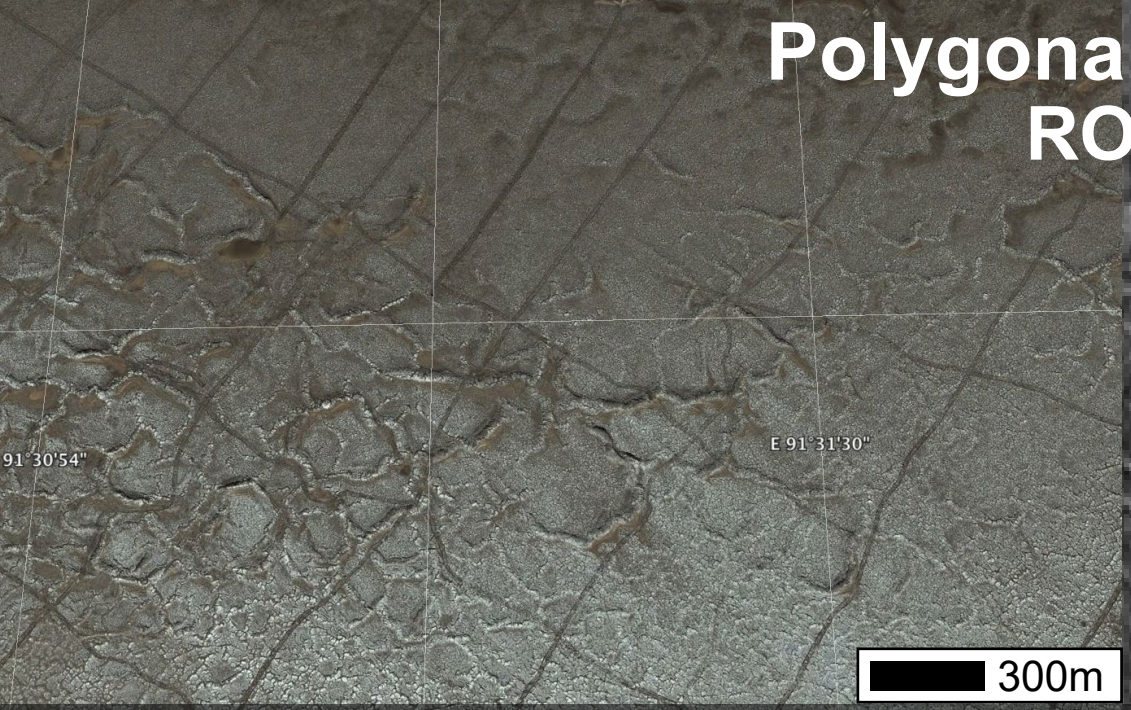
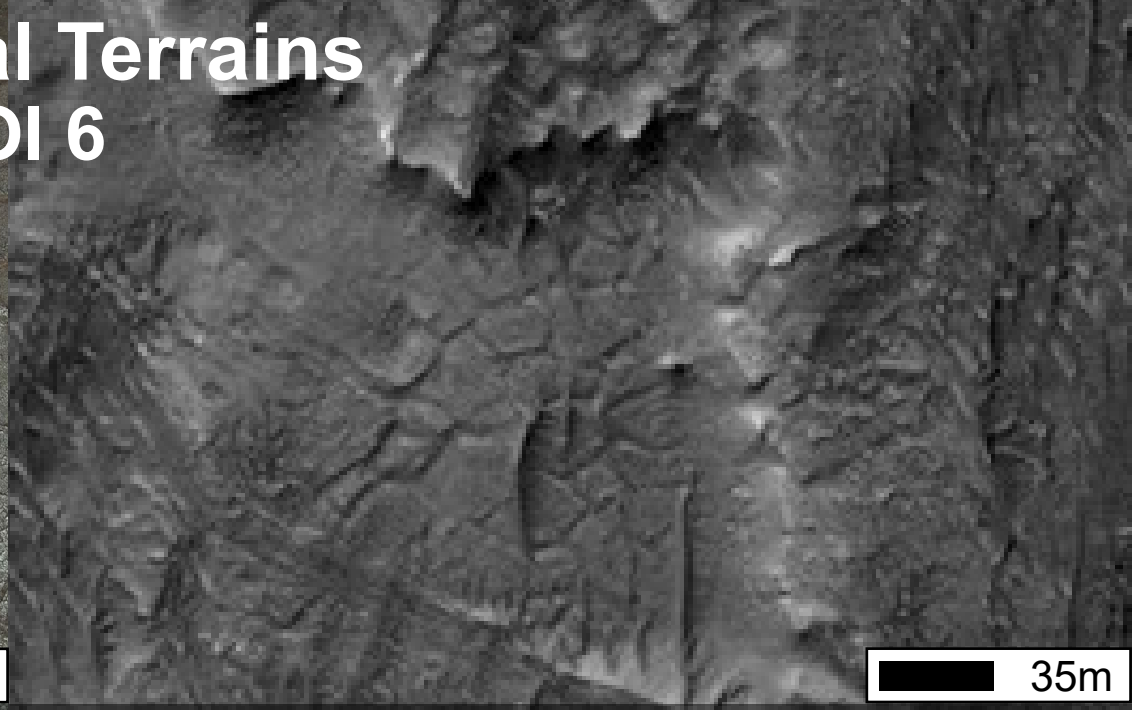
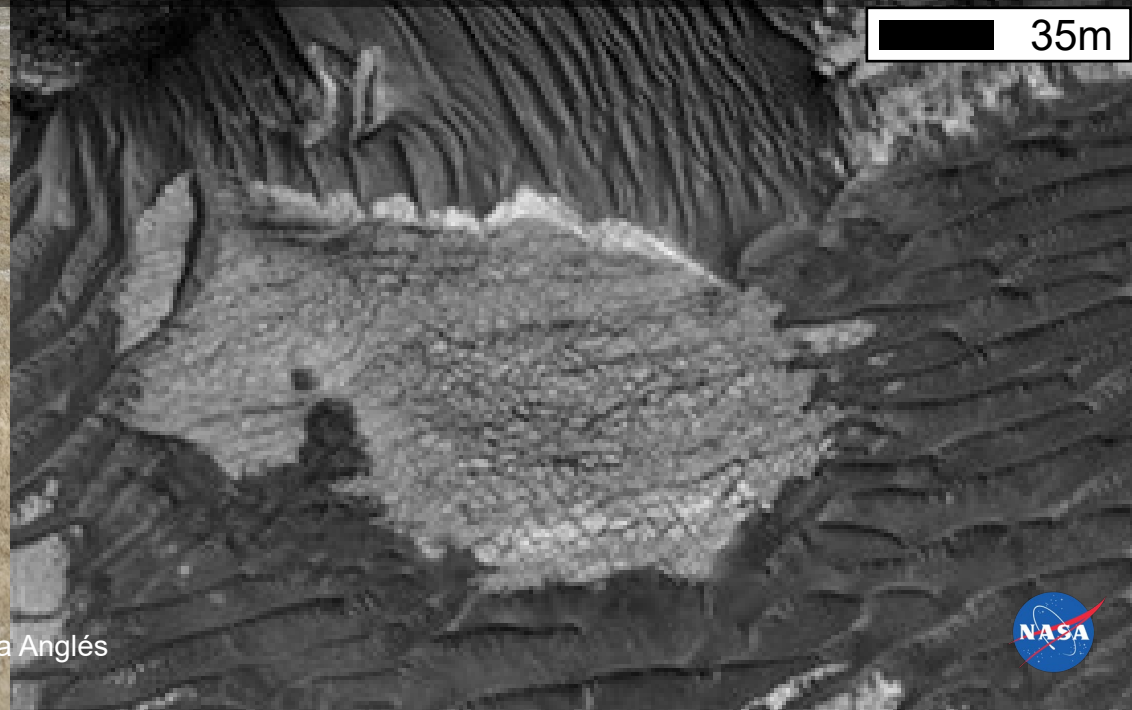
Polygonal Terrains
ROI 6





Qaidam Basin

Holden Crater



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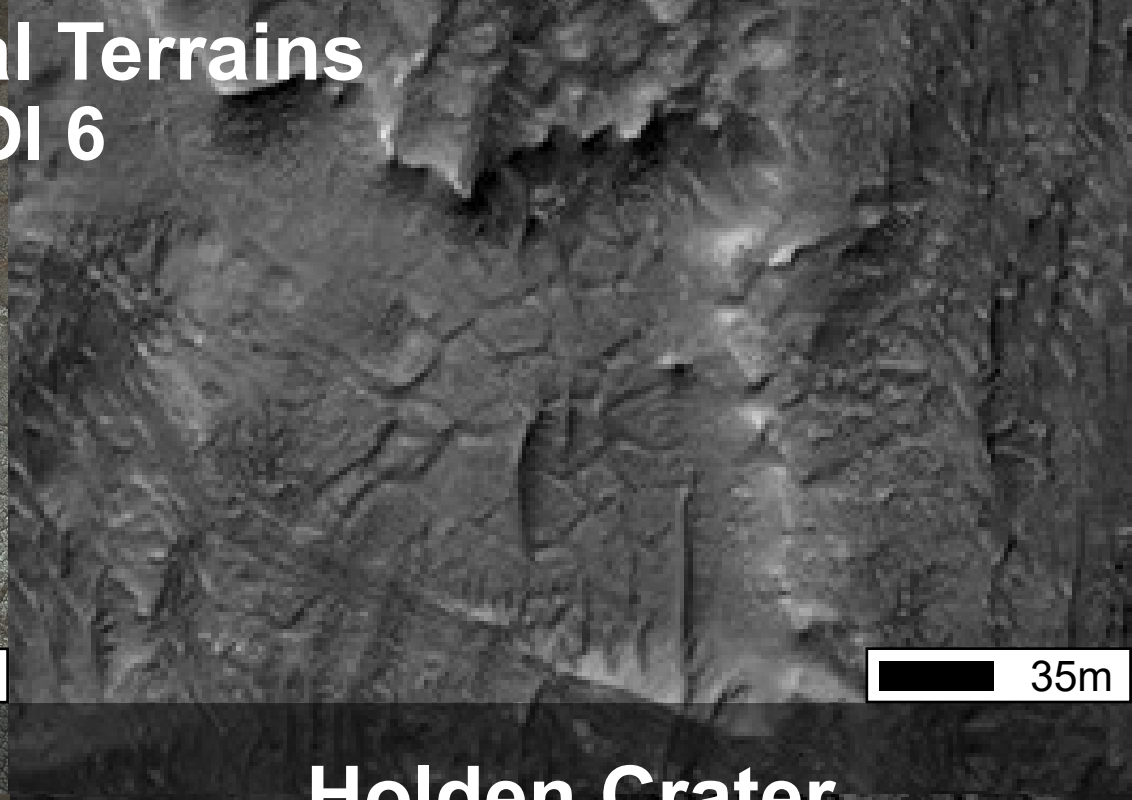
ROI 6

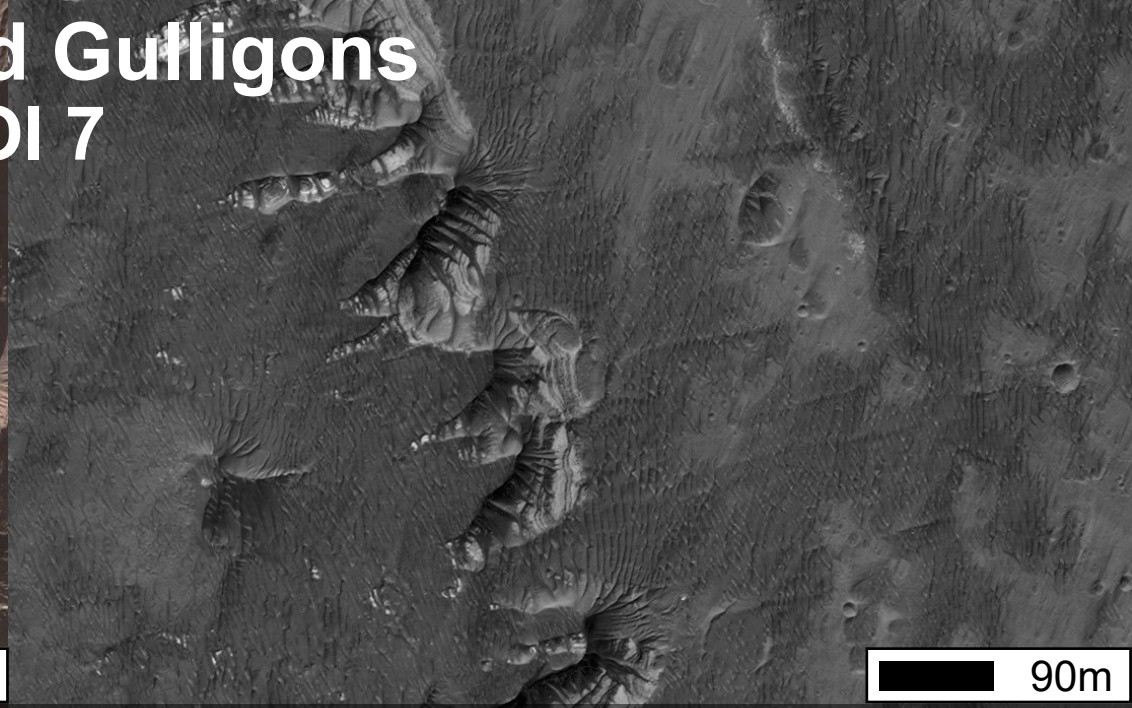


Qaidam Basin

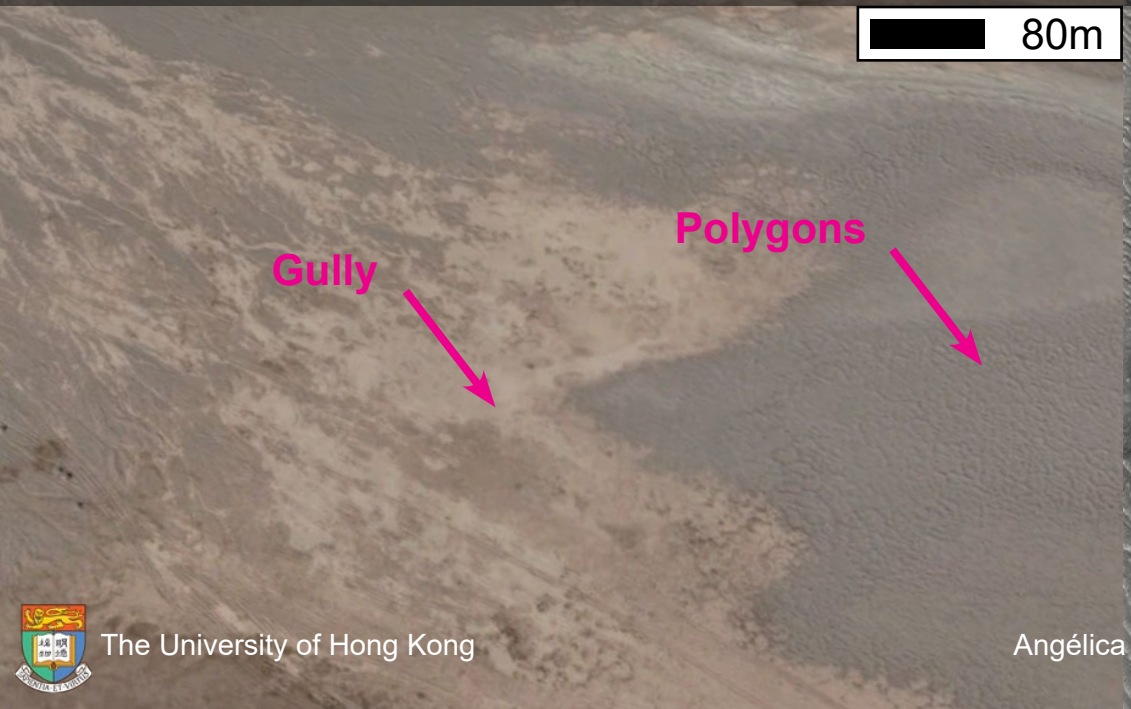
- gypsum
- quartz
- halite
- clinochlore
- epsomite
- pentahydrite

Holden Crater

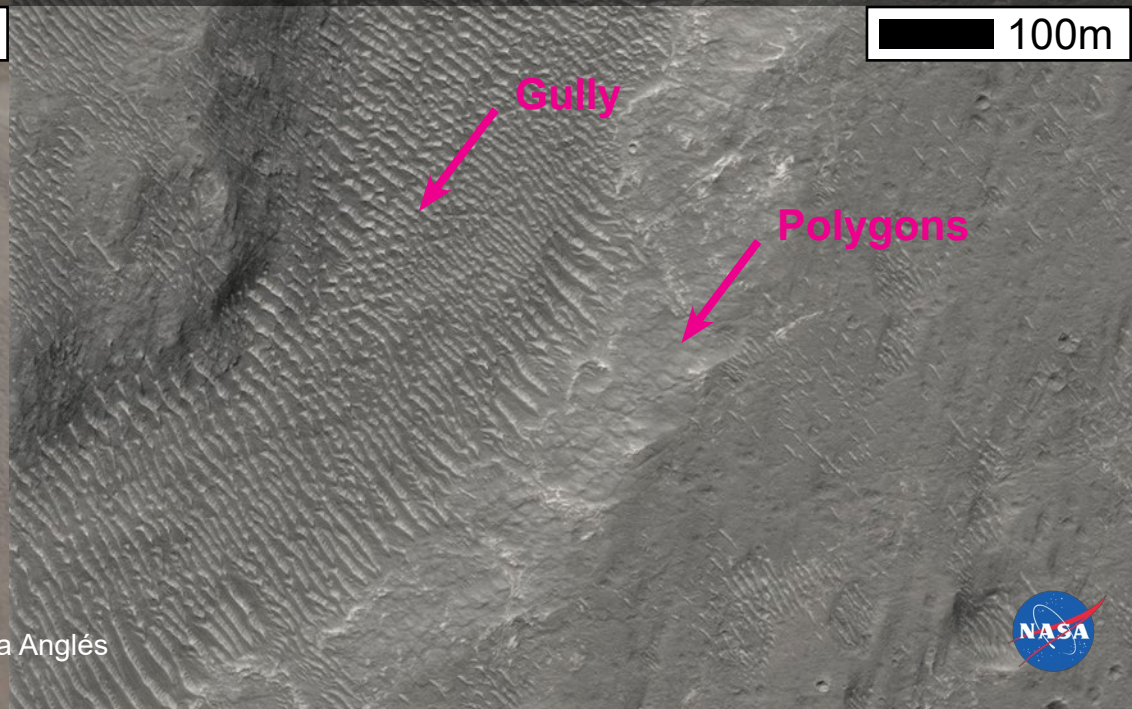
Gullies and Gulligons
ROI 7



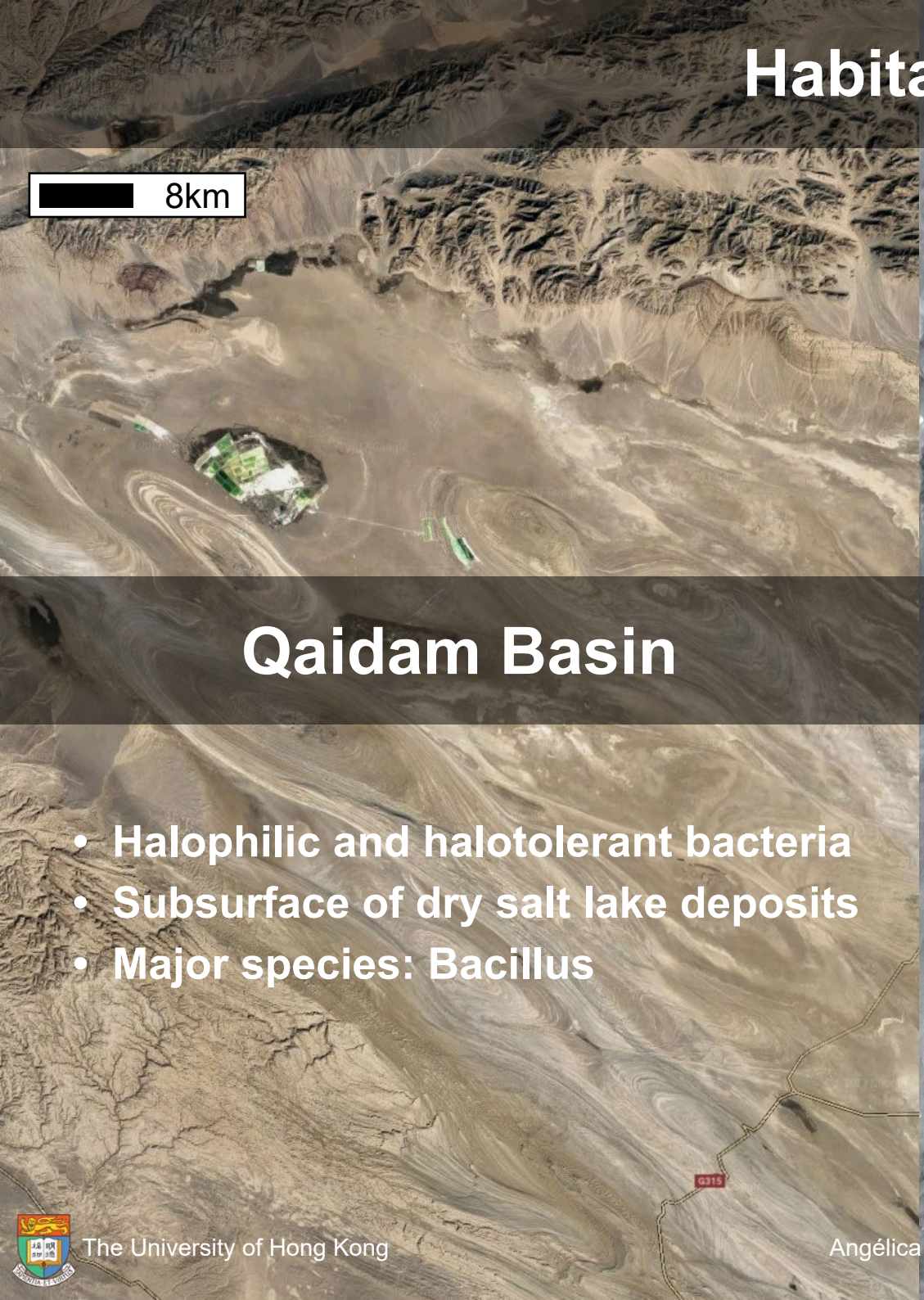
Qaidam Basin



Holden Crater

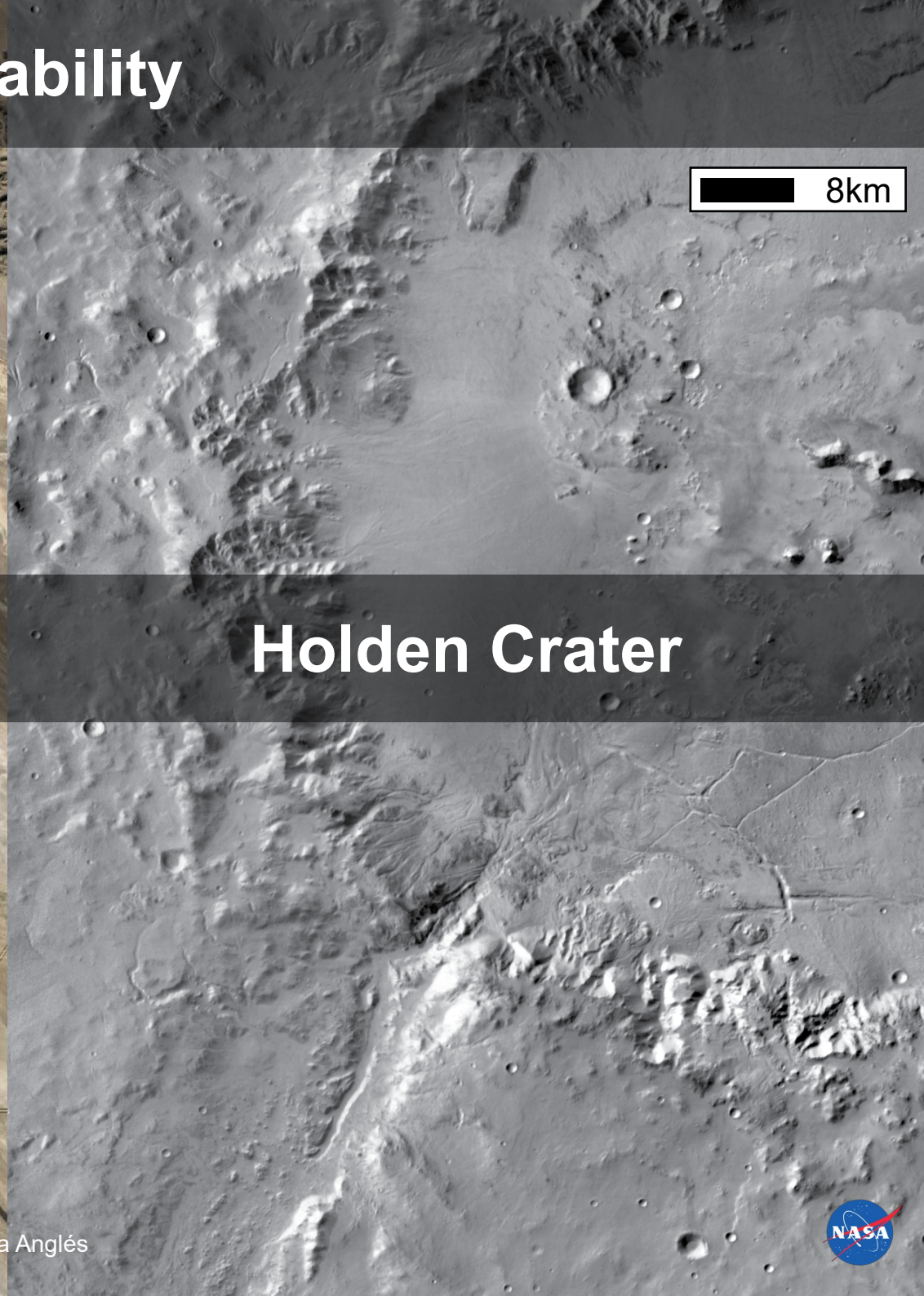


Habitability



Qaidam Basin

- Halophilic and halotolerant bacteria
- Subsurface of dry salt lake deposits
- Major species: Bacillus



Holden Crater

Conclusions

- High priority objectives within the landing ellipse
- Mineralogy that reflects changing environmental conditions
- Geology, biosignatures and catching
- Sites approachable by the rover
- Safe landing site and trafficability
- Analogue site: Qaidam Basin

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