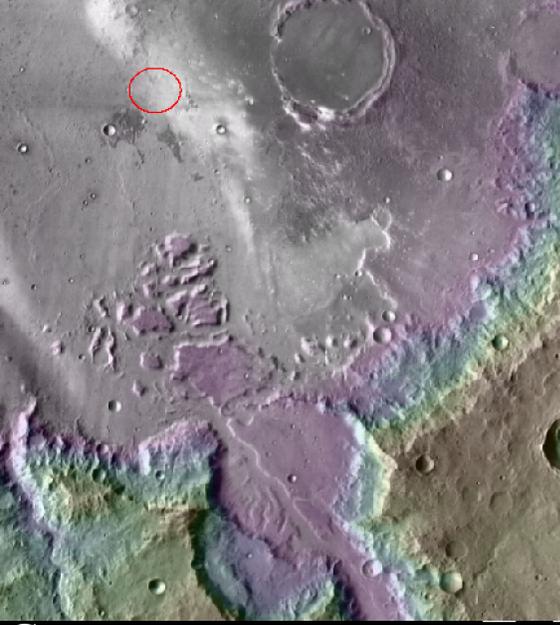


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Gusev crater



NE syrtis, Midway, Jezero

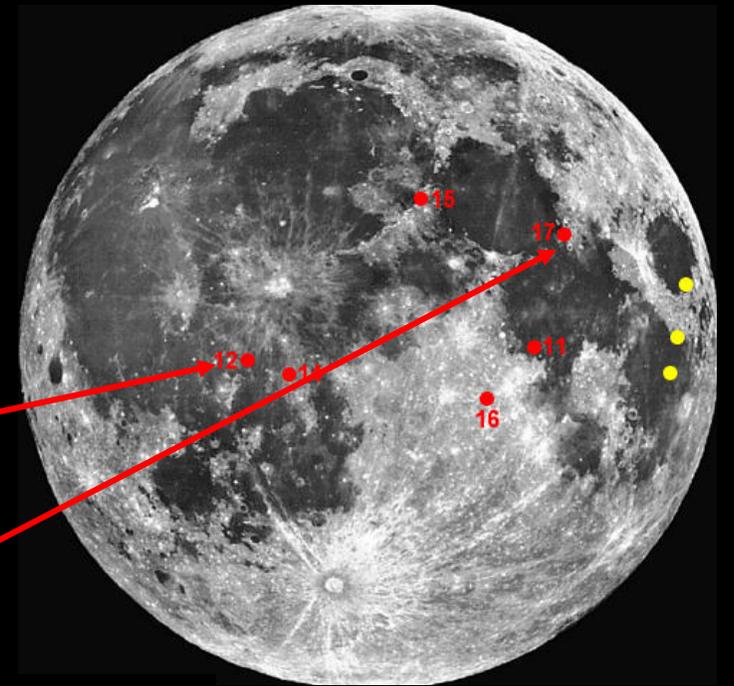
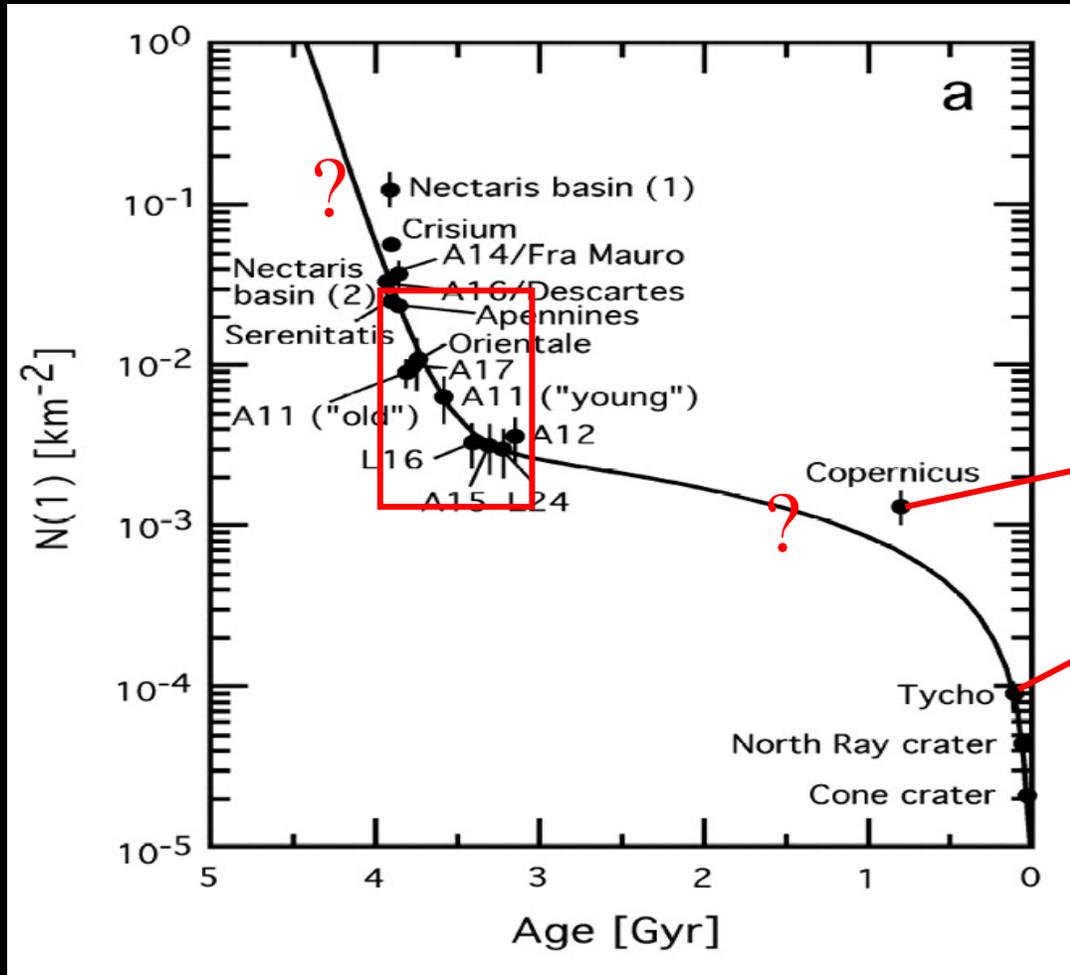
# Large diversity of landing sites

Quantin-Nataf C.<sup>1</sup>, Mandon L.<sup>1</sup>, Bultel B.<sup>2</sup>, Werner S.<sup>2</sup>

<sup>1</sup> University of Lyon (France)

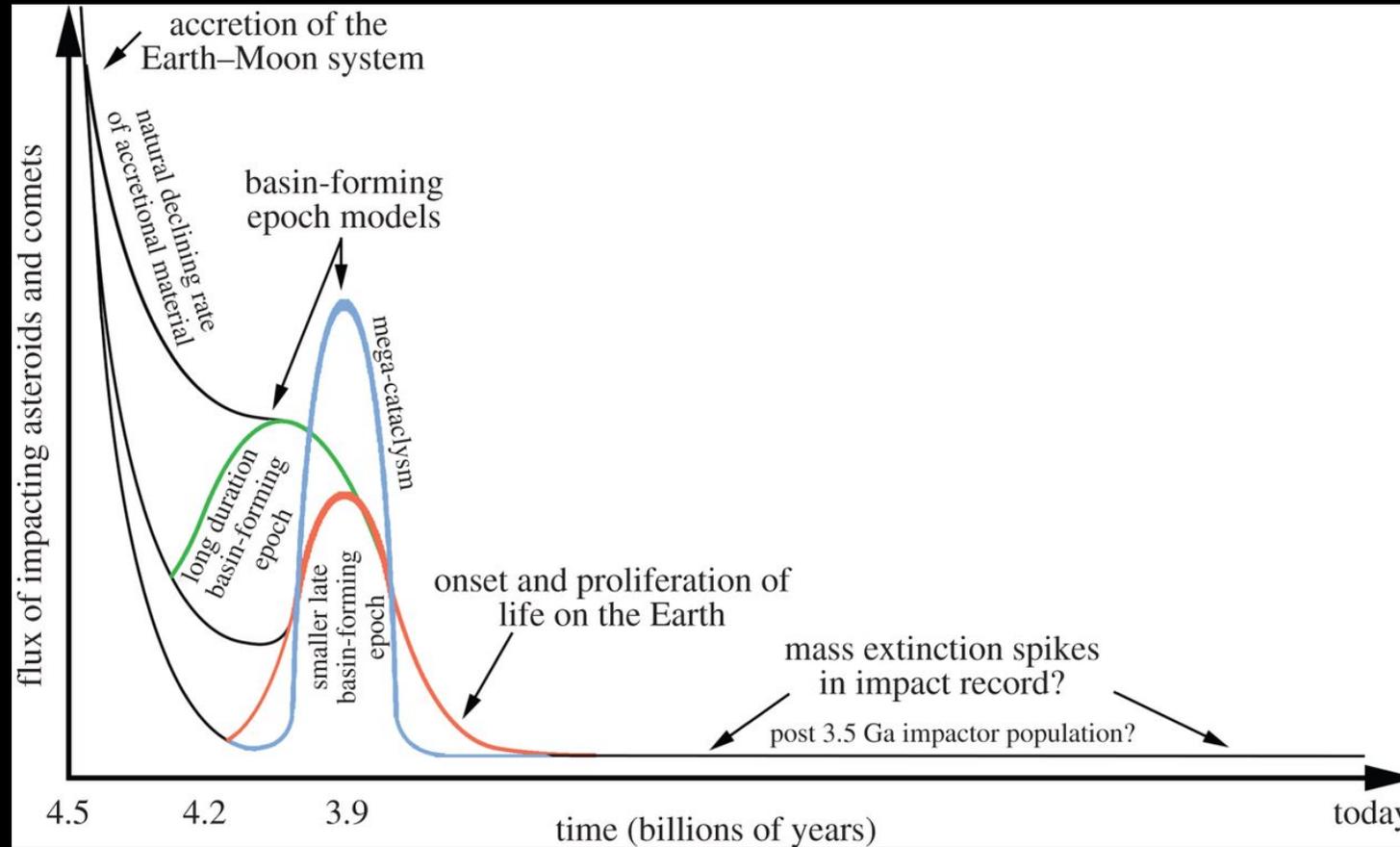
<sup>2</sup> University of Oslo (Norway)

# Uncertainty on Lunar Cratering Chronology



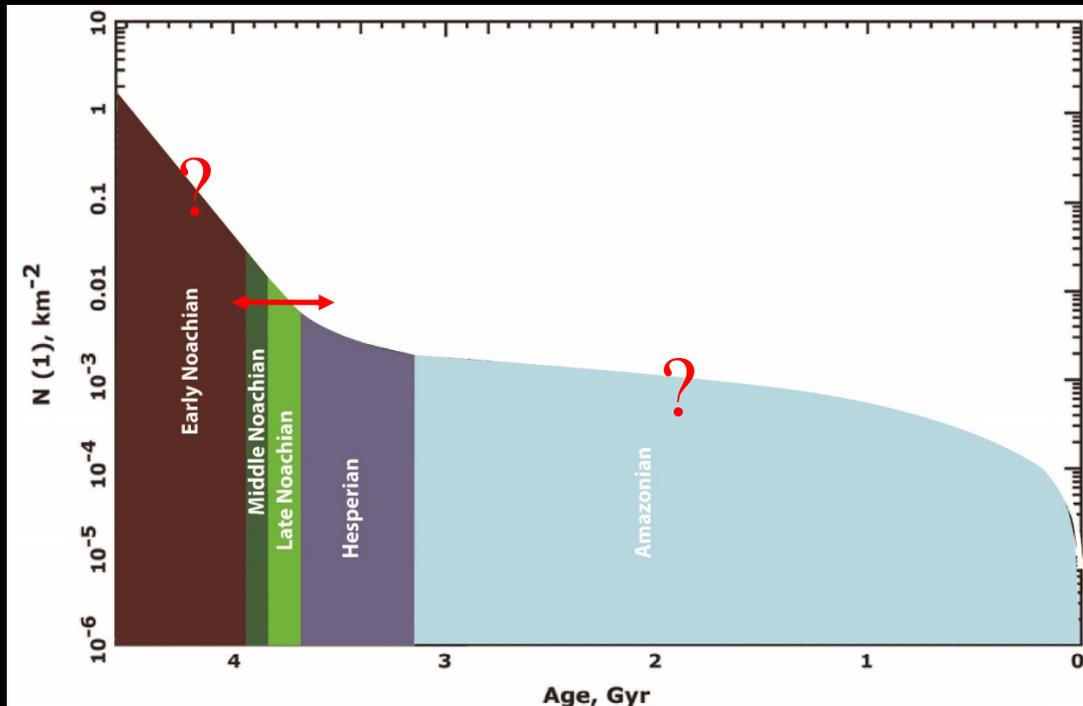
Stoffler et al. (2006)

# Uncertainty on Lunar Cratering Chronology

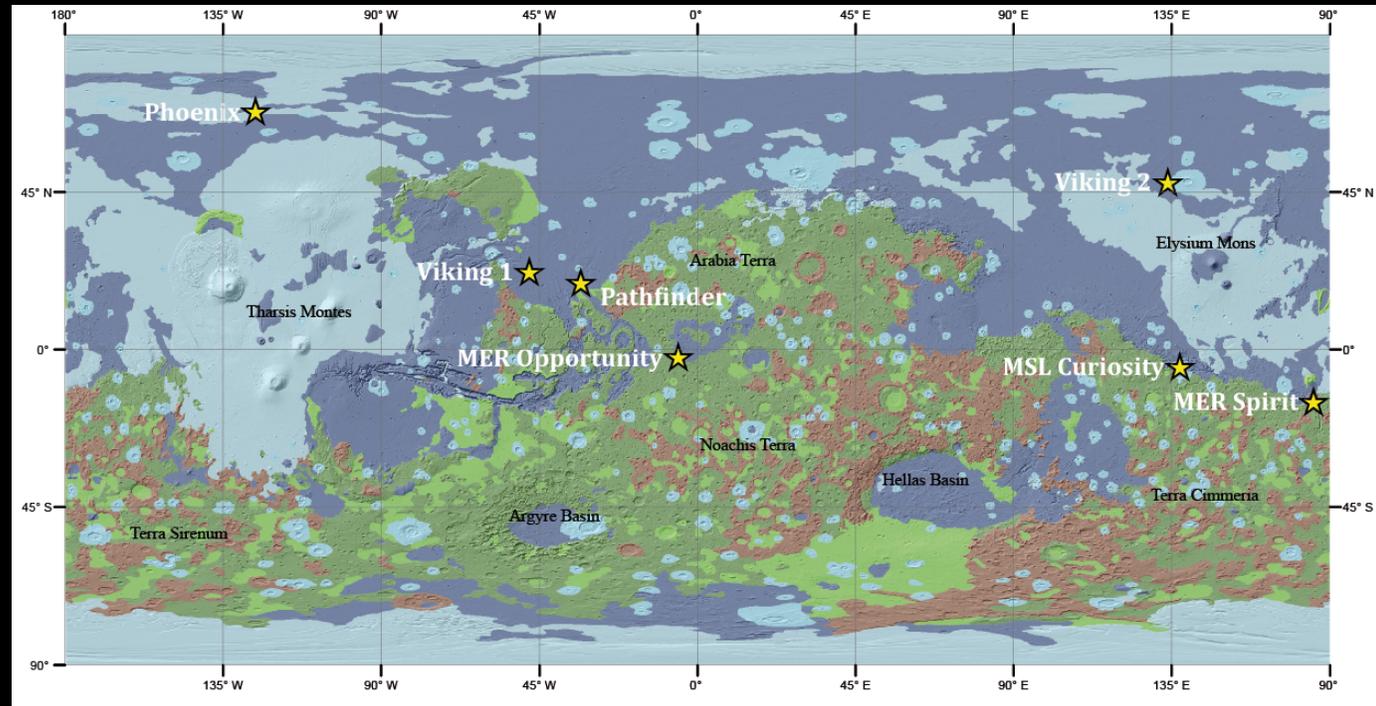


Crawford and Joy, 2014

# Mars : chronology, uncertainty and weakness



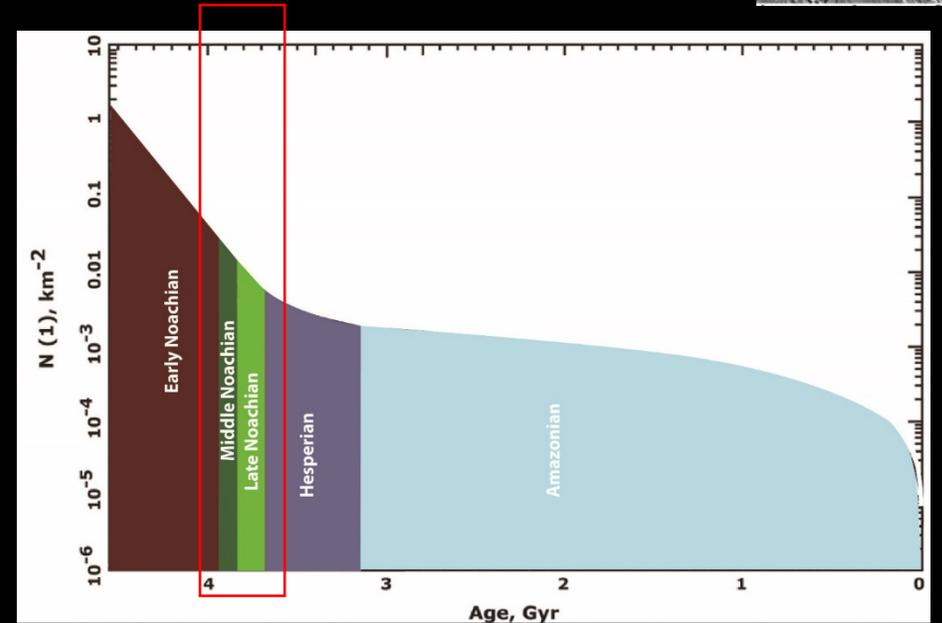
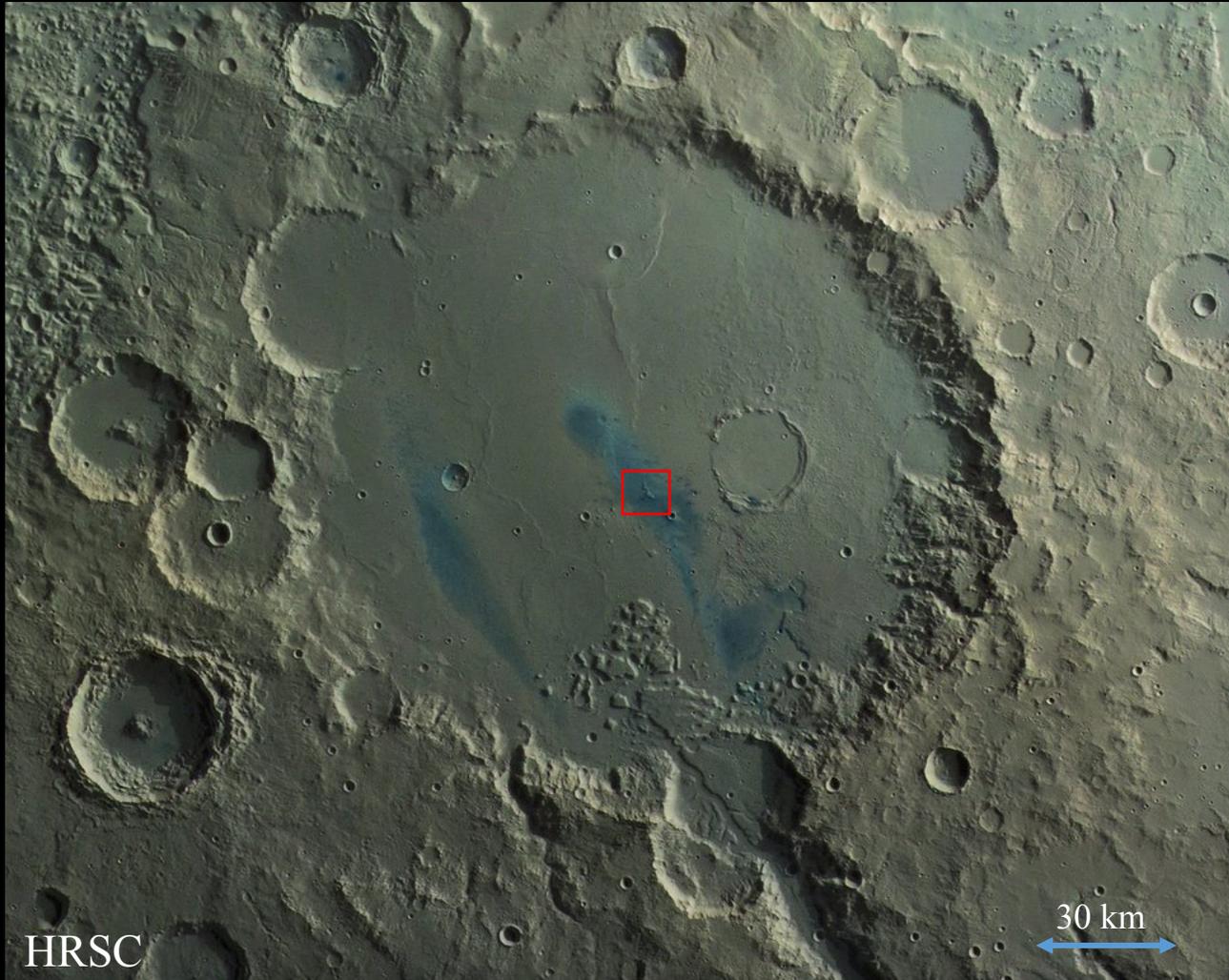
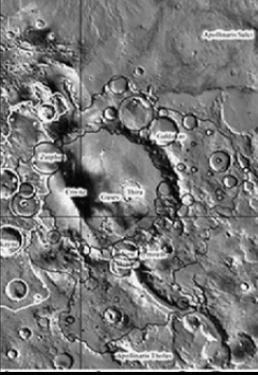
Modified from Hartmann and Neukum (2001)



From Tanaka et al., (2014)

Uncertainties of at least 200 My for ages  $>3.7$  Gy (Werner et al., 2014) and uncertainties much larger for Amazonian period

# Gusev crater-based chronostratigraphy



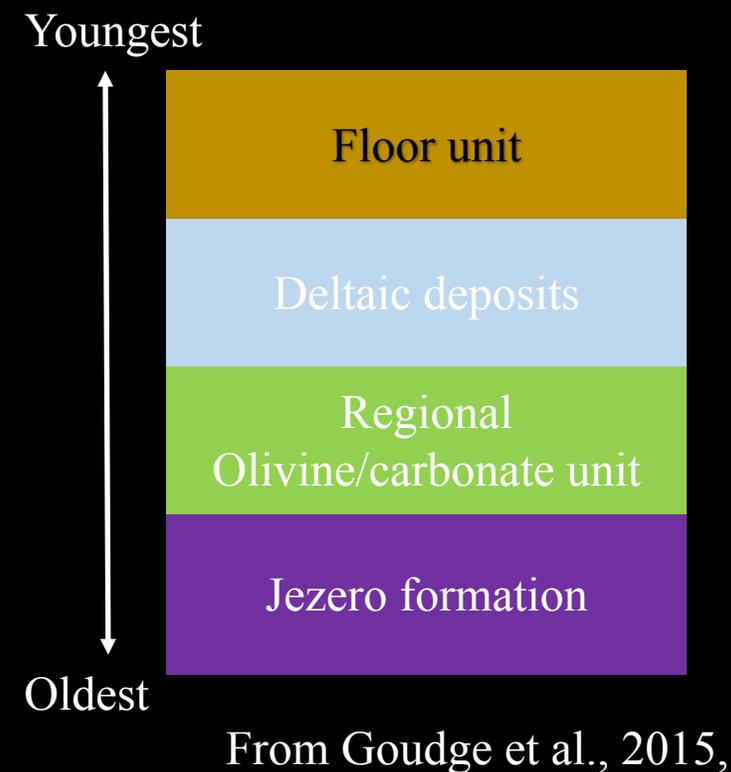
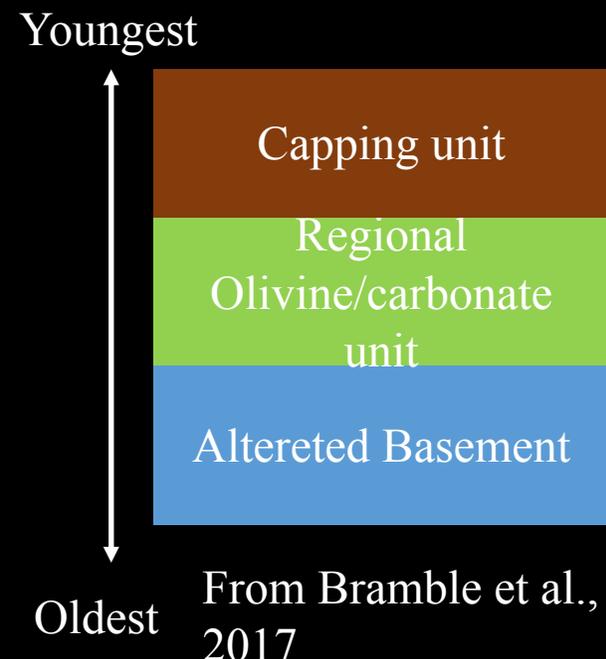
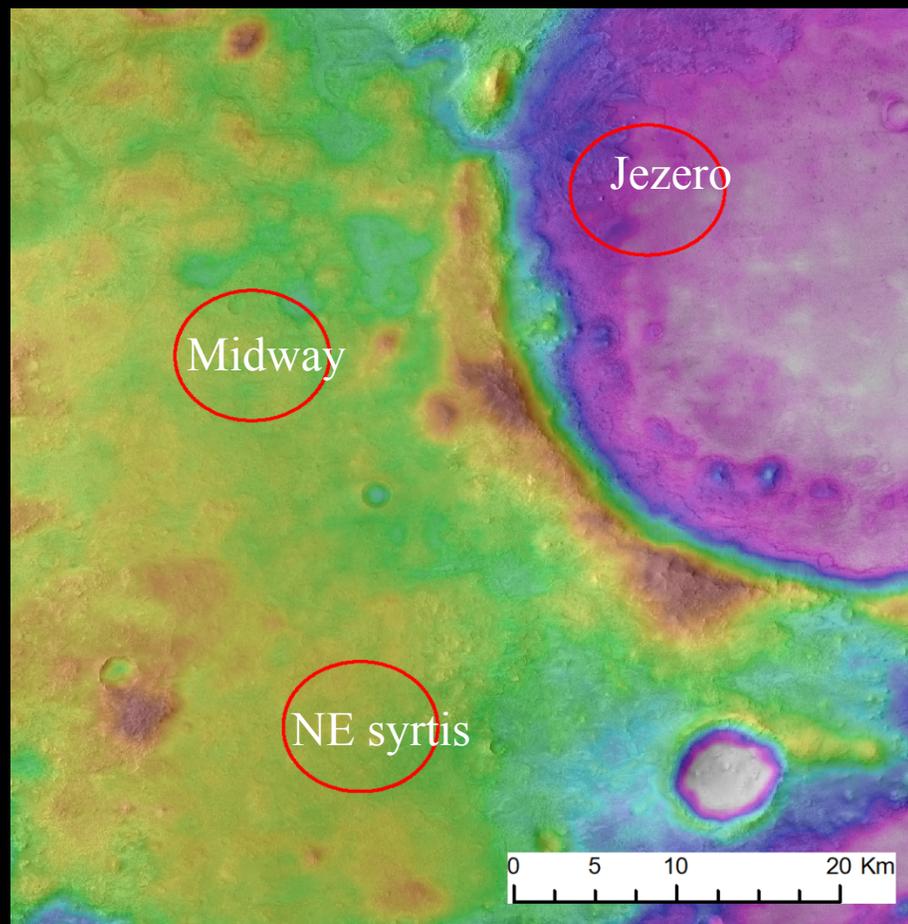
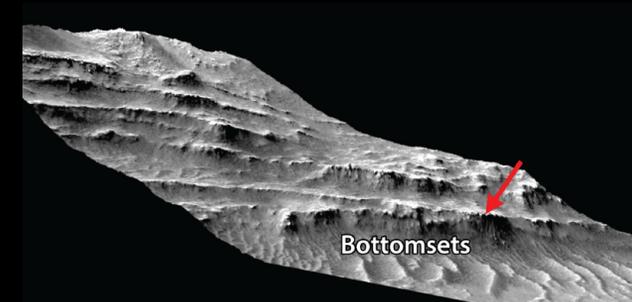
Crater formation : 4.1-3.9 Gy (Werner, 2008)  
Early to middle Noachian

Volcanic infilling: 3.65 Gy (Greeley et al., 2005)

# Main Stratigraphic units of NE syrtis, Midway and Jezero

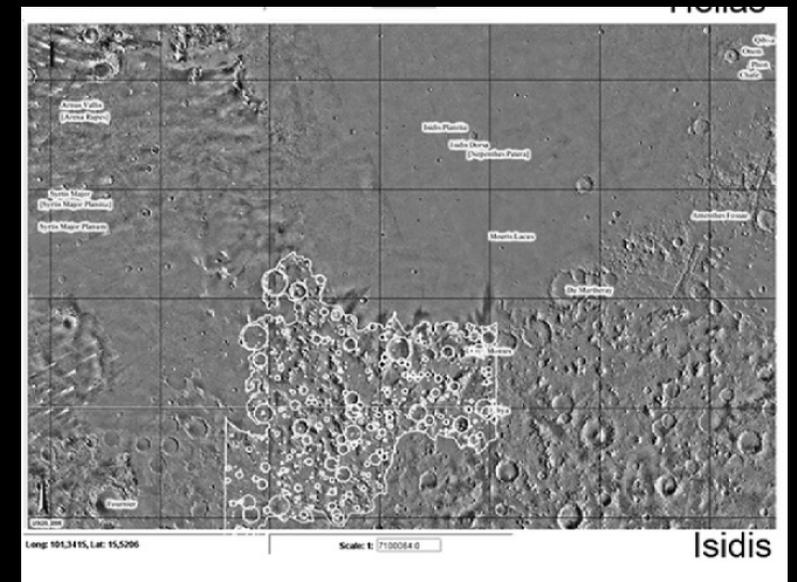
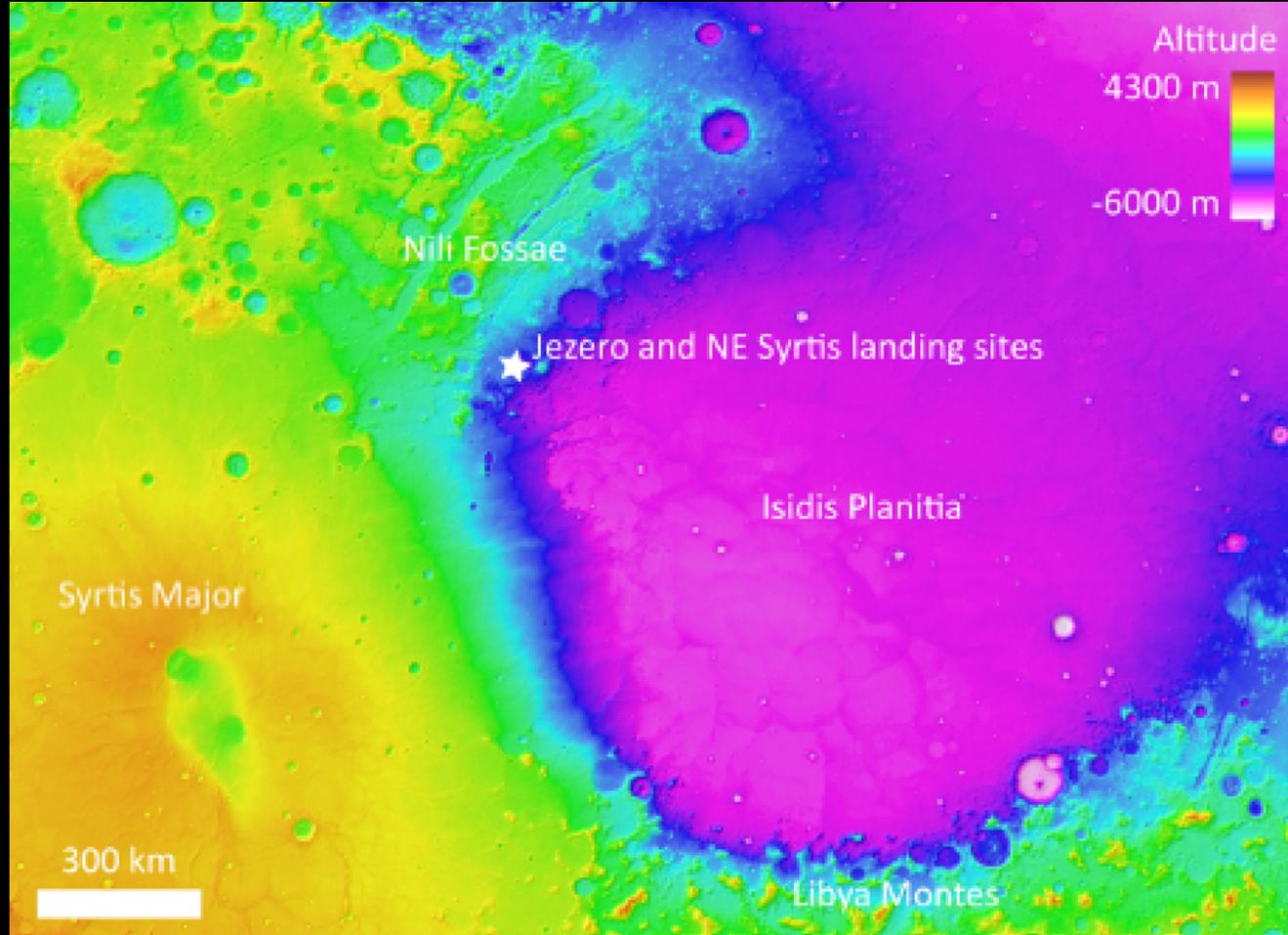


Bramble et al., 2017



# NE Syrtis and midway basement

- Noachian basement and Isidis formation



Isidis basin formation : 3.85 and 4.06 Gy  
(Werner, 2008)

Early to middle Noachian

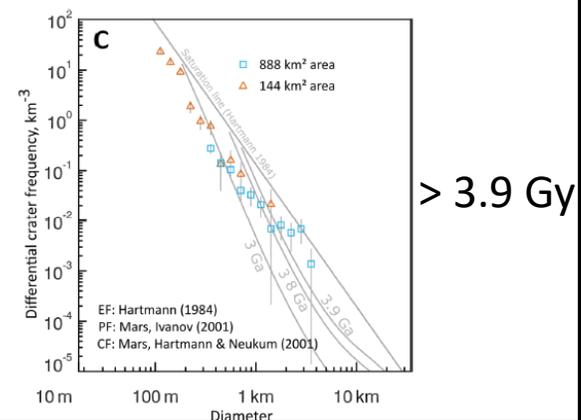
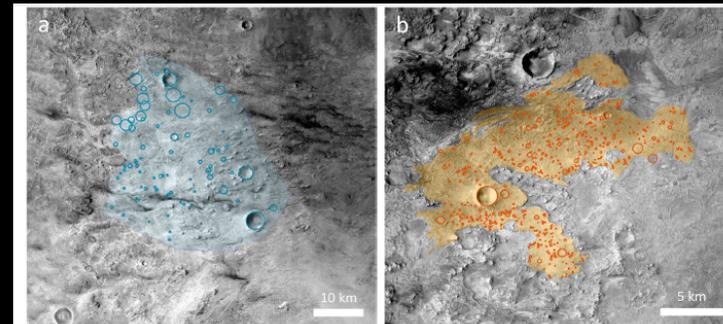
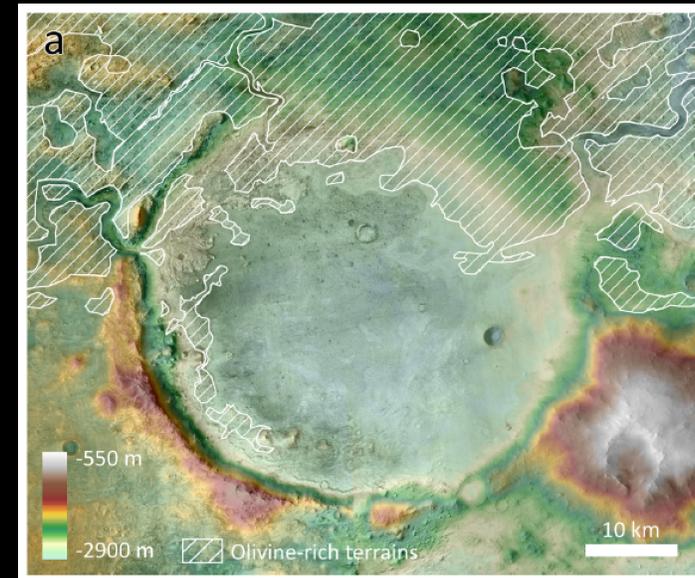
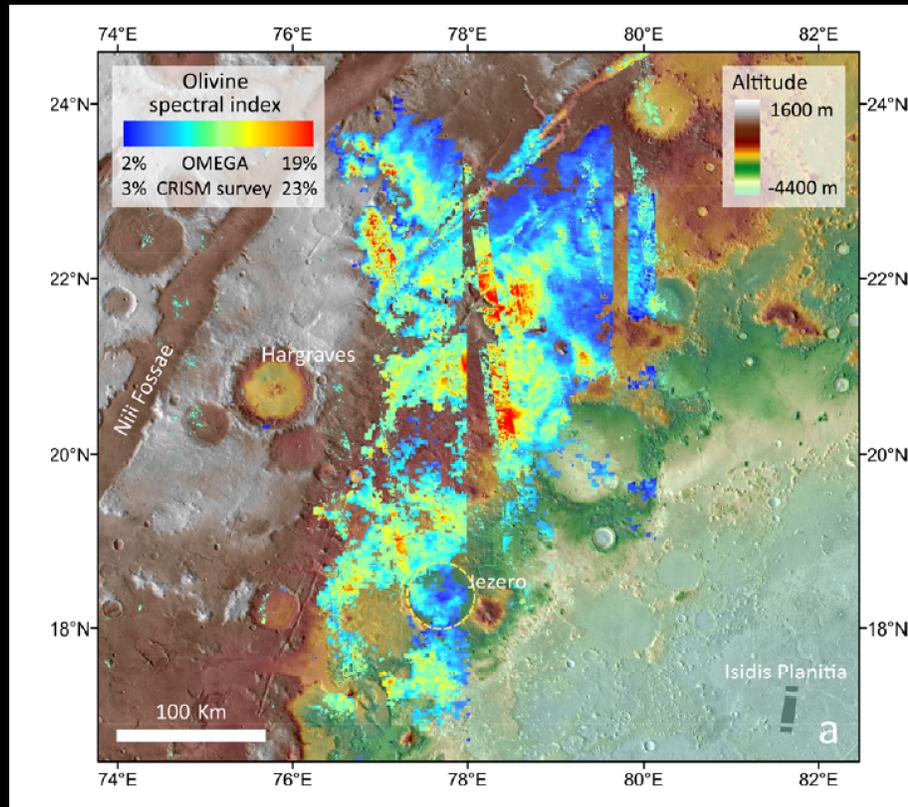


Megabreccias (Weiss et al., 2018) : > Isidis /Early Noachian

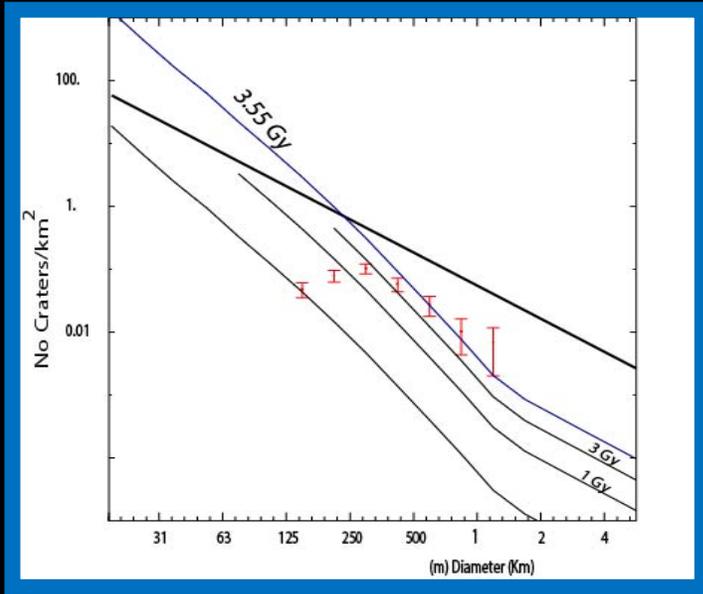
# Jezero Formation

Olivine rich unit > 3.9 Gy

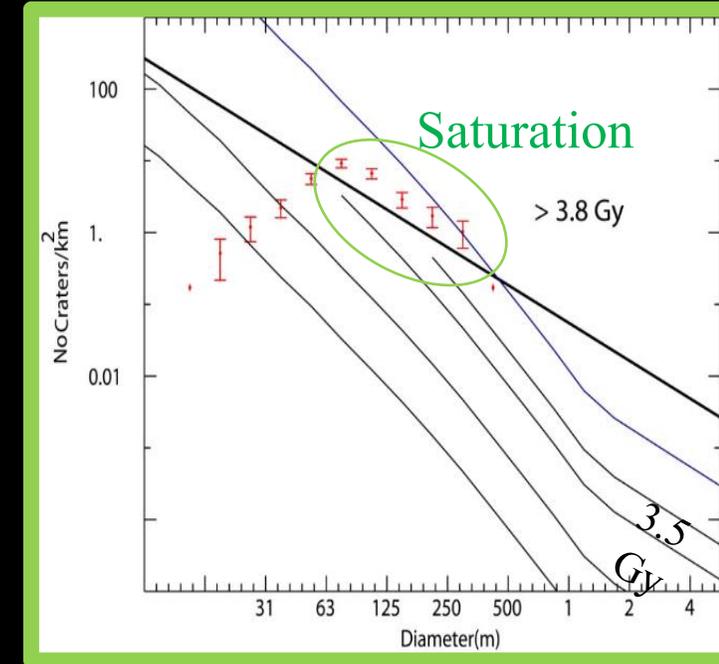
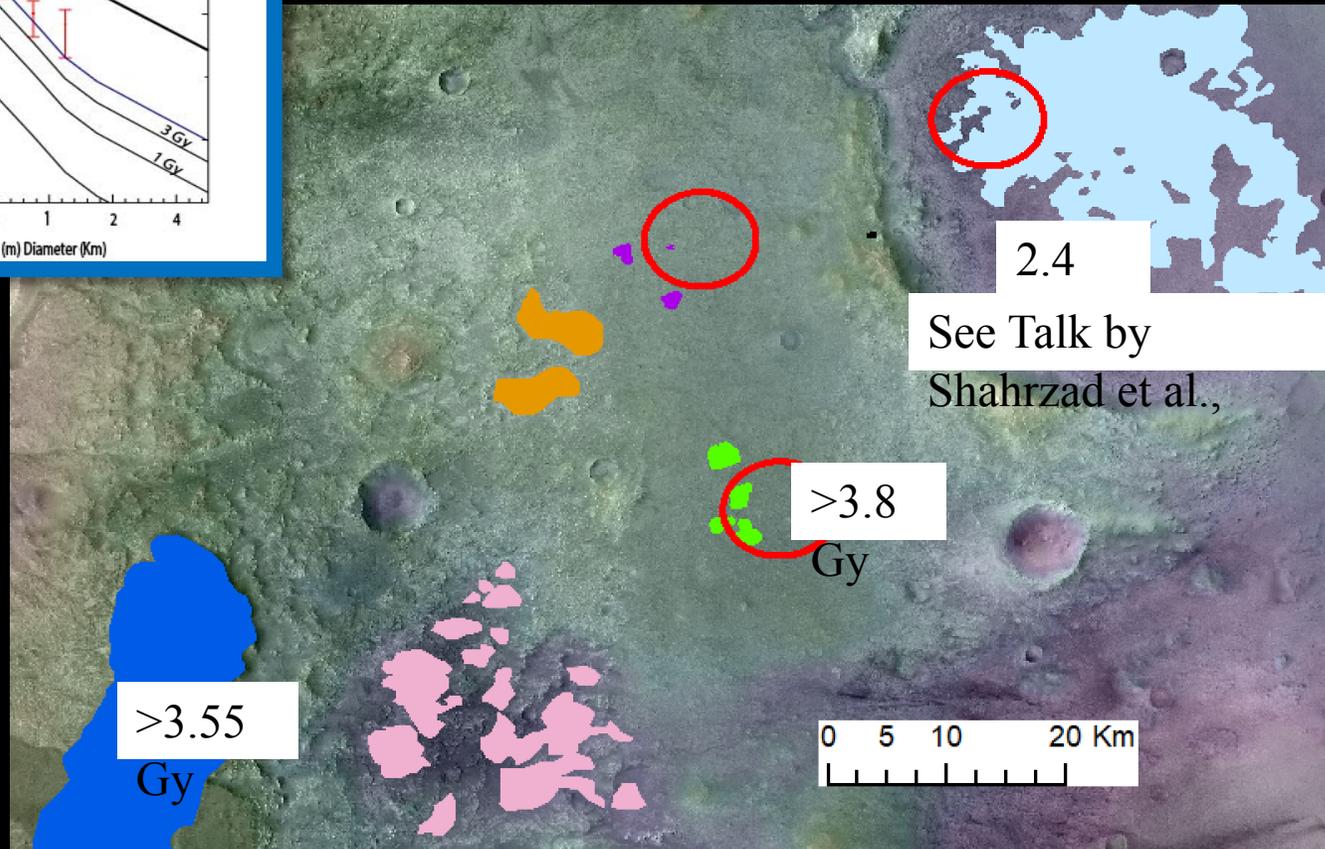
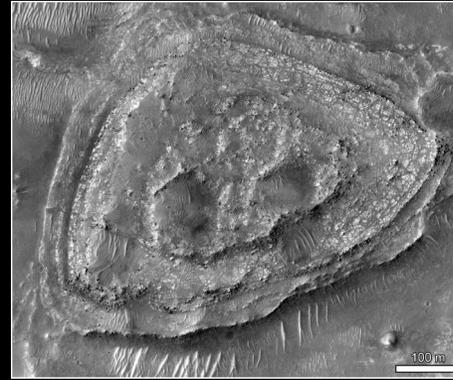
Jezero > Olivine rich unit > 3.9 Gy



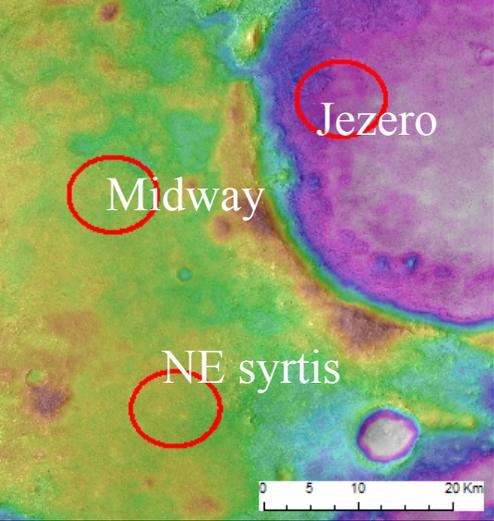
# Crater-based ages of the crater-retaining units



Syrtis lava flow



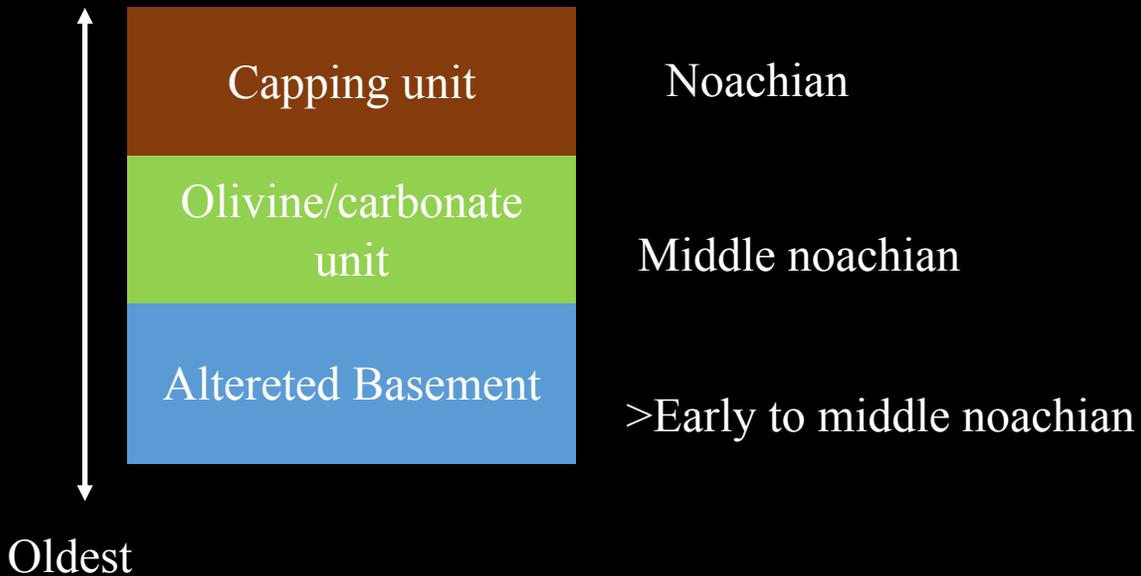
NE syrtis mesa's caps



# Chronostratigraphy of NE syrtis, Midway and Jezero

## NE syrtis, Midway

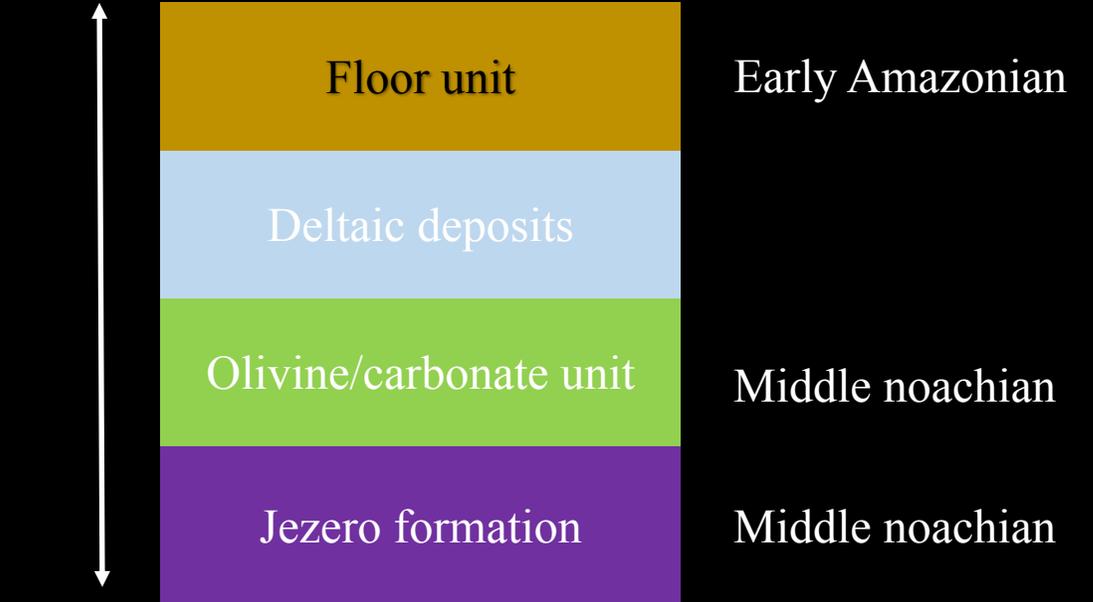
Youngest



Oldest

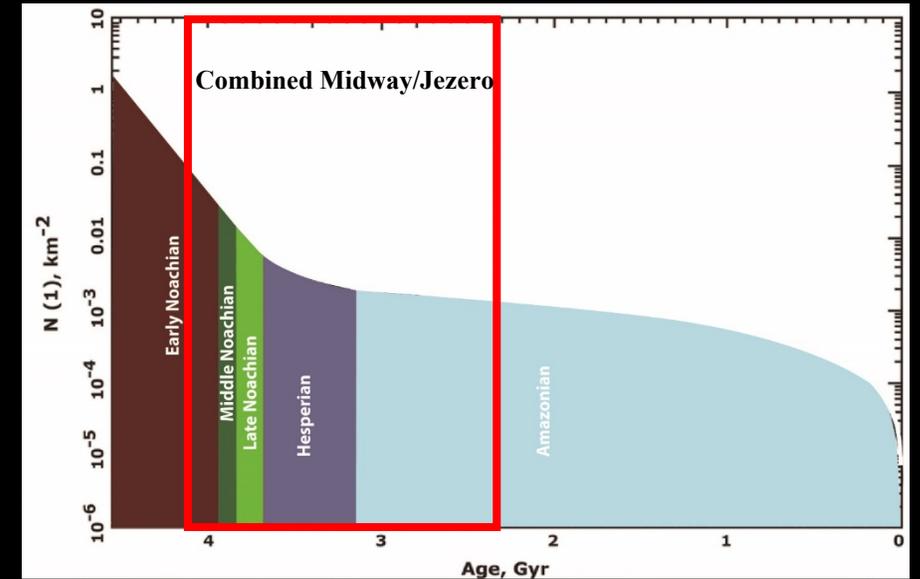
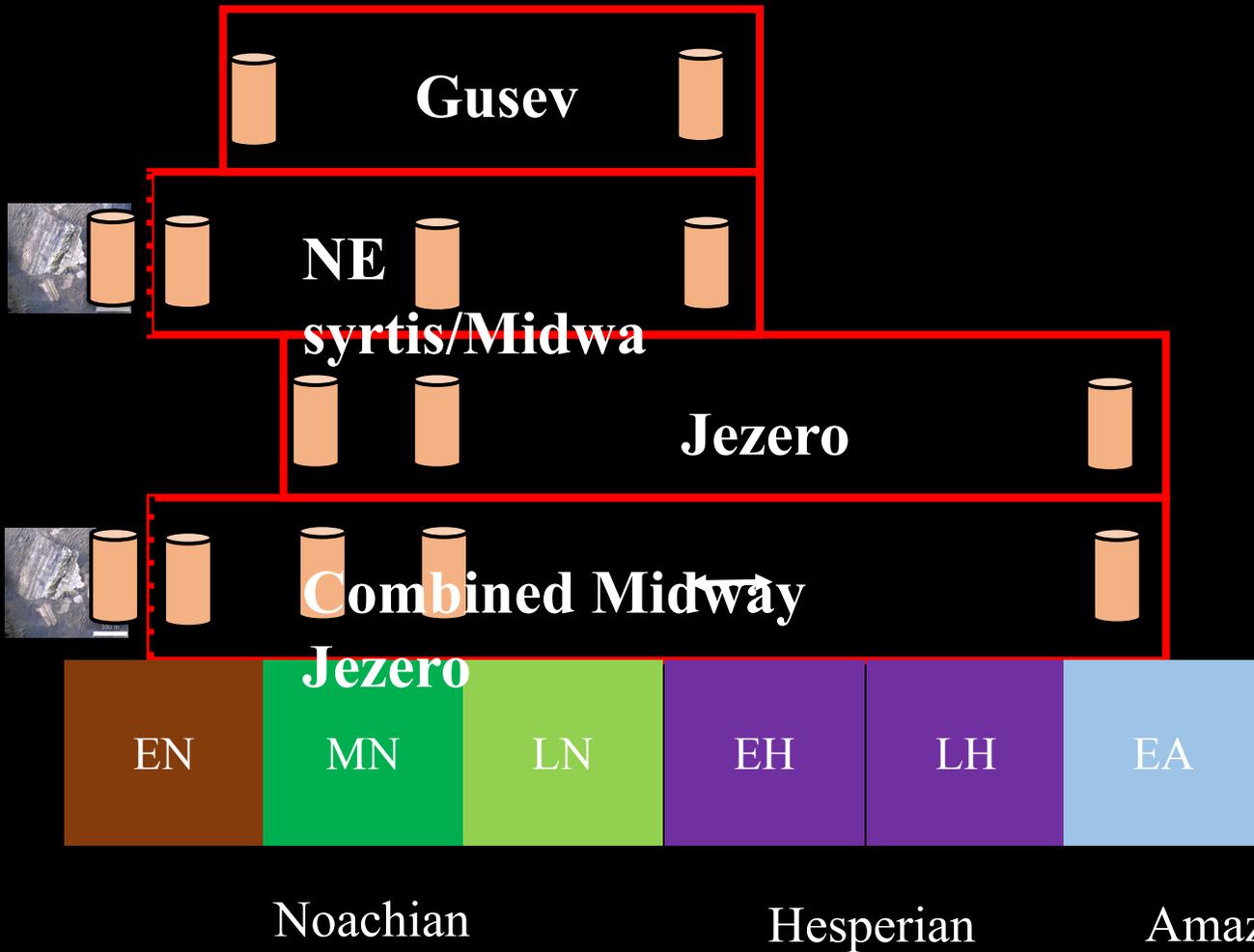
## Jezero

Youngest

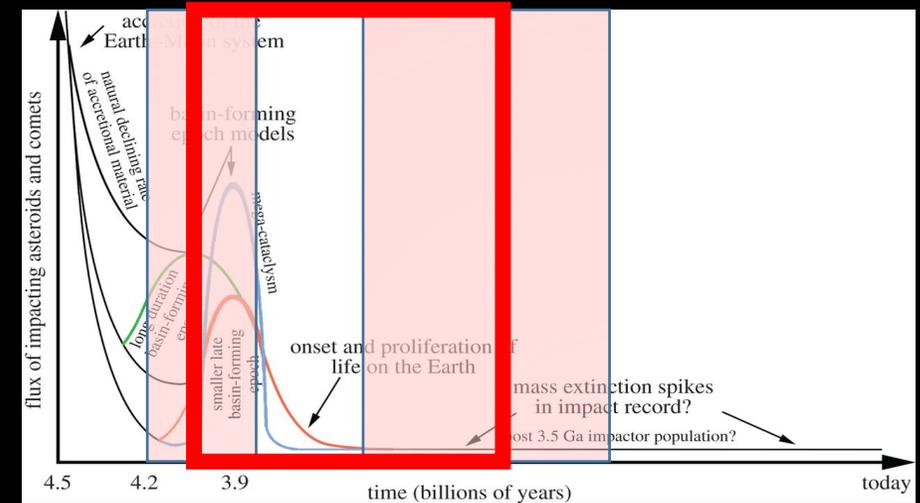


Oldest

# Conclusions



Modified from Hartmann and Neukum (2001)



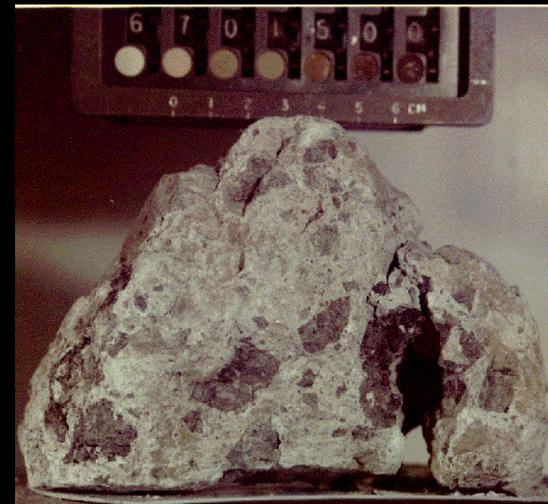
Modified from Crawford and Joy, 2014

# Supplementary material ability to date impact basin

Samples from Apollo 16 used to date Nectaris impact basin formation (attributed to Nectaris ejectas)

Stoeffler and Ryder, 2001

Sample*	Description	$^{40}\text{Ar}$ - $^{39}\text{Ar}$	Rb-Sr
Fragmental breccias	14064,31	KREEP melt clast	3.81 ± 0.04
	67015,320	feldspathic melt blobs	3.90 ± 0.01
	67015,321	VHA melt blob	3.93 ± 0.01 (K-Ar)
Glassy breccias and glass	61015,90	coat	1.00 ± 0.01
	63503 particle 1m	glass fragment	2.26 ± 0.03
	67567,4	slaggy bomb	0.84 ± 0.03
	67627,11	slaggy bomb	0.46 ± 0.03
	67946,17	slaggy bomb	0.37 ± 0.04
Crystalline melt breccias	14063,215	poikilitic impact melt	3.89 ± 0.01
	14063,233	aphanitic impact melt	3.87 ± 0.01
	14167,6,3	melt	3.82 ± 0.06
	14167,6,7	melt	3.81 ± 0.01
	15294,6	poikilitic, Gp. Y	3.87 ± 0.01
	15304,7	ophitic, Gp. B	3.87 ± 0.01
	15356,9	poikilitic, Gp. C	3.84 ± 0.01
	15356,12	poikilitic, Gp. C	3.87 ± 0.01
	60315,6	poikilitic	3.88 ± 0.05
	63503 particle 1c	VHA?	3.93 ± 0.04
	65015	poikilitic	3.87 ± 0.04
	65785	ophitic	3.91 ± 0.02
	72215,144	aphanite; feldsite melts	3.83 ± 0.03
	72255	aphanite; feldsite melts	3.85 ± 0.04
	72215,238b	aphanite	3.87 ± 0.02
	73215	aphanite; feldsite melts	3.84 ± 0.05
	77075,18	veinlet (Serenitatis)	3.93 ± 0.03
	72395,96	poikilitic (Serenitatis)	3.89 ± 0.02
	72535,7	poikilitic (Serenitatis)	3.89 ± 0.02
	76055	magnesian, poikilitic	3.92 ± 0.05
76055,6	magnesian, poikilitic	3.78 ± 0.04	
76055,6	magnesian, poikilitic	3.78 ± 0.04	
Clast-poor impact melts	14073	subophitic 14310-group	3.80 ± 0.04
	14074	subophitic 14310-group	3.80 ± 0.04
	14276	subophitic 14310-group	3.80 ± 0.04
	14310	subophitic	3.88 ± 0.05
	14310	subophitic; plag	3.82 ± 0.04
	65795	subophitic, very feldspathic	3.81 ± 0.04
	60635	subophitic, 68415-group	3.75 ± 0.03
	65055	subophitic, 68415-group	3.89 ± 0.02
	67559	subophitic, 68415-group	3.76 ± 0.04
	68415	subophitic	3.80 ± 0.06
68416	subophitic, 68415-group	3.71 ± 0.02	
Granulitic breccias and granulites	14063,207		3.90 ± 0.02
	14179,11	clast	3.97 ± 0.01
	15418,50		3.98 ± 0.06
	67215,8		3.75 ± 0.11
	67415		3.96 ± 0.04
	67483,13,8		4.20 ± 0.05
	72255,235b	clast	3.85 ± 0.02



*Breccia attributed to Nectaris (Apollo 16 sample 67015) NASA/Johnson Space Center photograph S72-37216.*