

2 Science

(JAXA)

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Phase-2

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Science 2023 2 24 ()

Macromolecular organic matter in samples of the asteroid (162173) Ryugu
Science

D O I 10.1126/science.abn9057

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JAXA

(Phase-1)

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Phase-2

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Phase-2

2

6 Phase-2

2

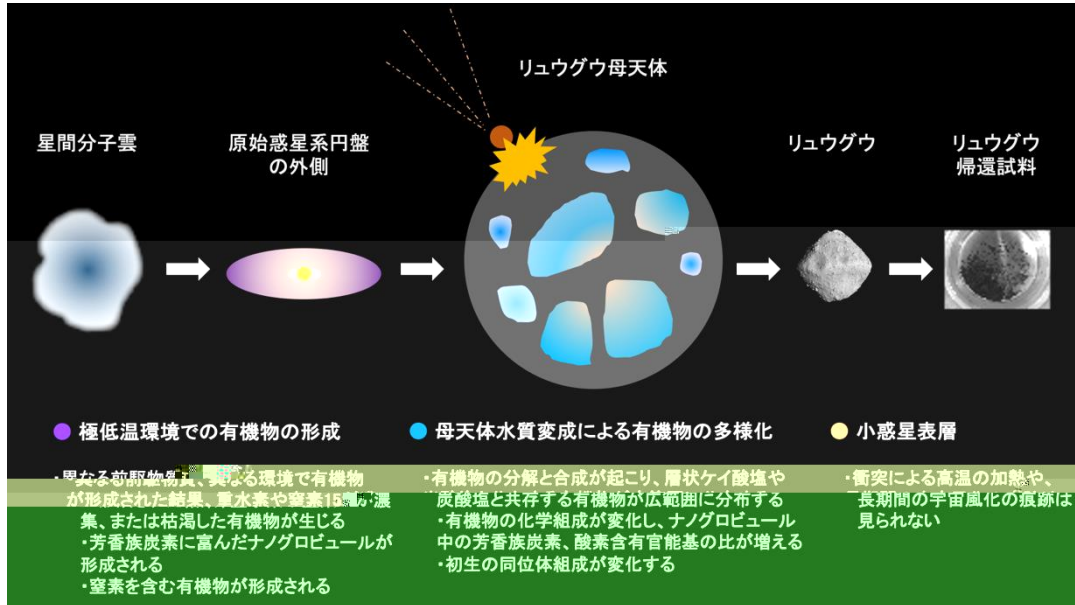
()
()

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Macromolecular organic matter in samples of the asteroid (162173) Ryugu



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1:

1

1

2

2.

46

S

C

X

AFM

1

2

3, 6, 9

3

5, 9) i)

ii)

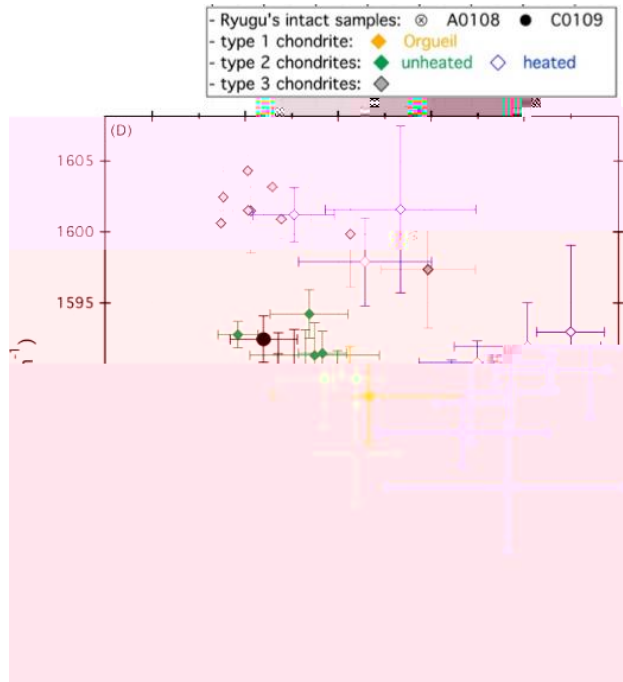
iii) ()

iv)

2.
(a)

(b)

()



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4.

D

G

(D, G)

[

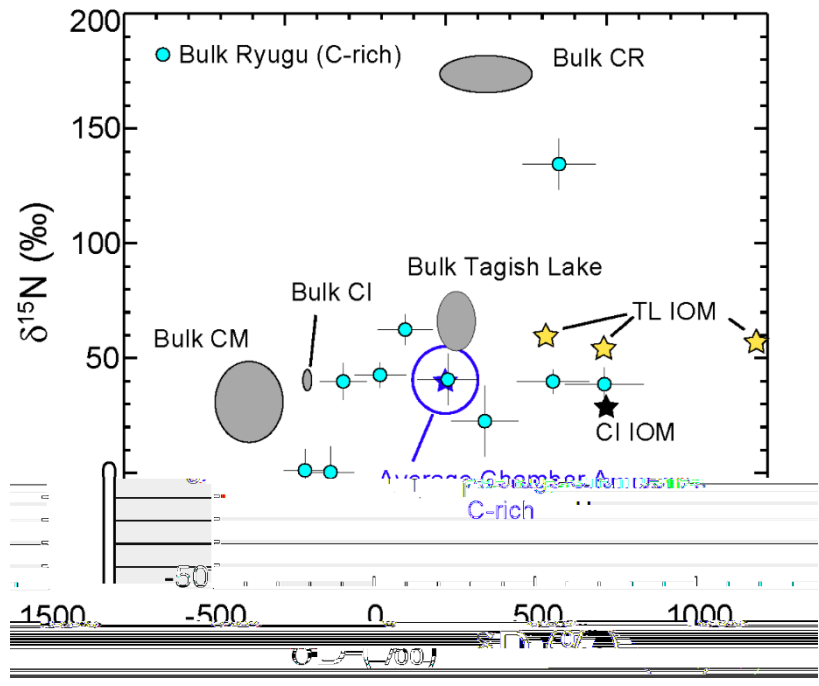
4)

($\delta^{15}\text{N}$)(2)
 δD $\delta^{15}\text{N}$

(5)(

Cl

(δD)
 Cl
 δD $\delta^{15}\text{N}$



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5. δD $\delta^{15}N$

(12) (100 nm)

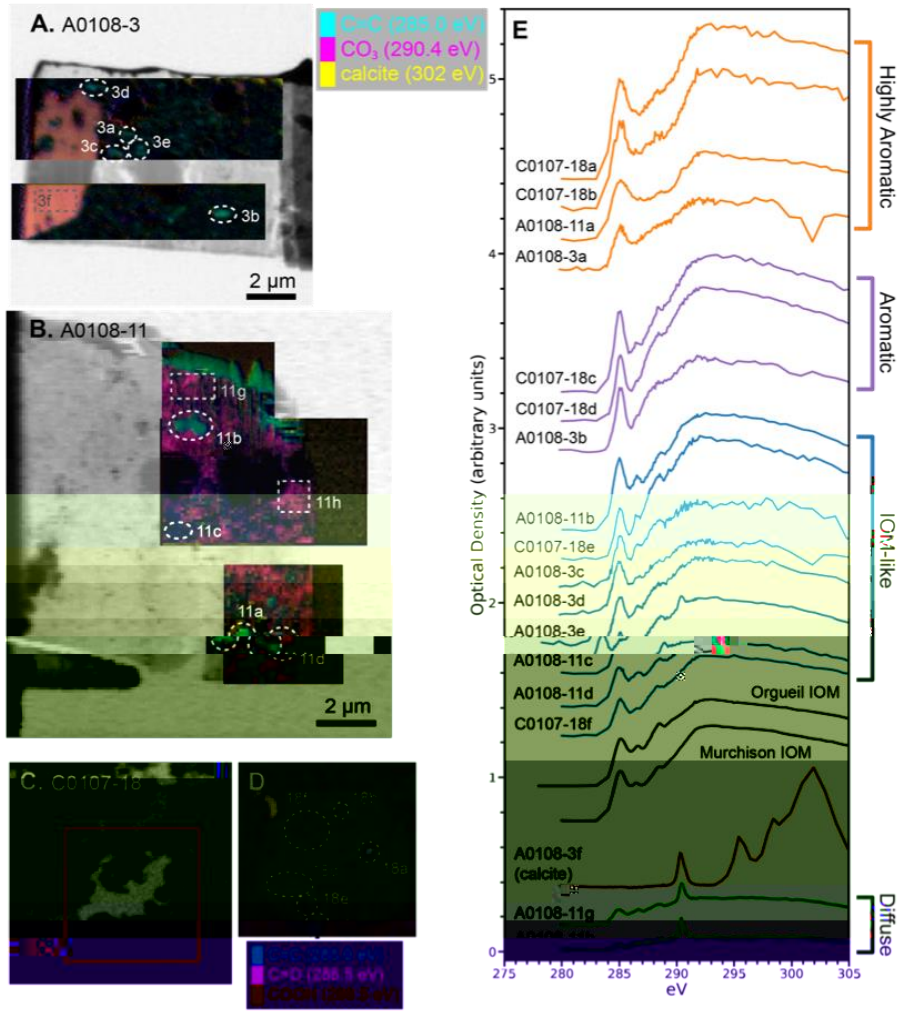
X AFM

X () (diffuse carbon

) (6, 7,

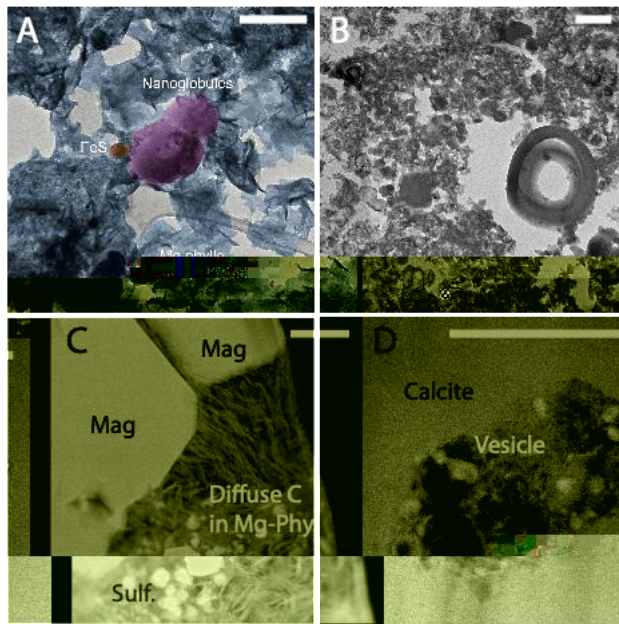
8) (6, 7, 8)

() (6, 7)



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	6.		X			
(A)	(B)		X		X	
	(C)				X	(D) (C)
		(E) (A), (B), (D)		C-XANES		X
		(290.4 eV)	(285.0 eV)	(286.5 eV)	(288.5 eV)	



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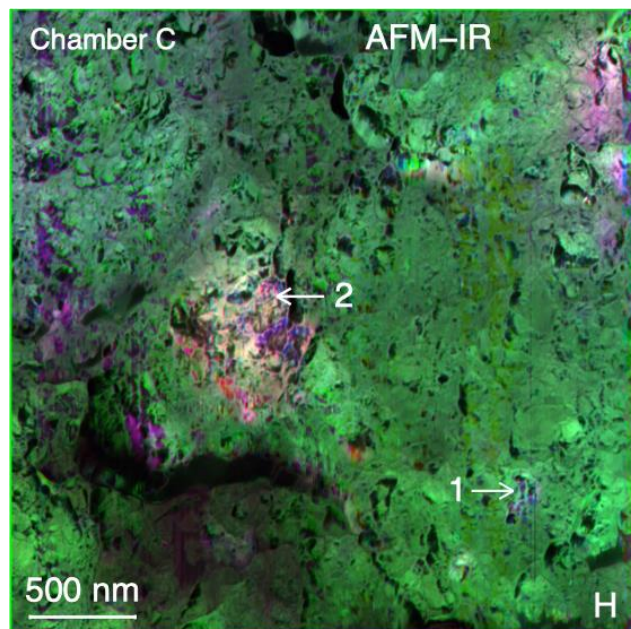
7.

500 nm. (A)

(B)

(C) 6B 11h 2 (Mag)
 (diffuse carbon) (Sulf) (D)

6A 3a



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8.

AFM

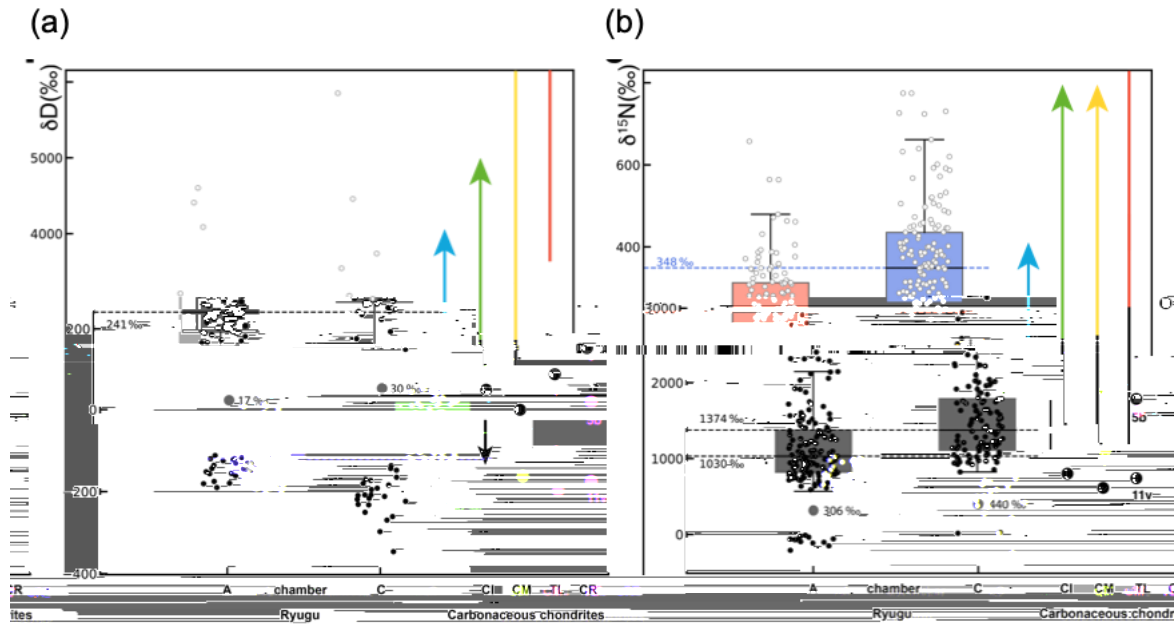
C=O (1720 cm^{-1})

C=C (1600 cm^{-1})

Si-O (1020 cm^{-1})

()

D / ^{15}N () ()
) (9) D / ^{15}N
 (200)



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9. (CI, CM, Tagish Lake, CR)

(a) (δD) (b) ($\delta^{15}\text{N}$)

7

C

C2

(D)

δD () CI, CM

(11v) (

) (5b) (9)

CR

(9)

δD



D

(

C

D

(N/C) CI, CM
81P/ 2

N/C

N/C

N/C

C

D

3.

Science

Macromolecular organic matter in samples of the asteroid (162173) Ryugu

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4.

(1)

(Glavin et al. 2018)

(CM)

1 6

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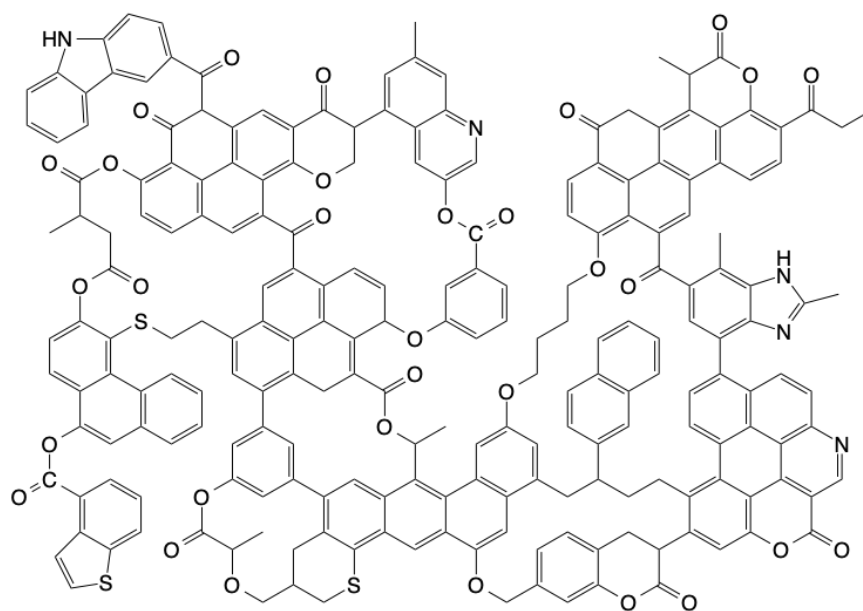
75

17

4

3

(Alexander et al. 2007)



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(2)

(R)

$R () = [(R / R) - 1] \times 1000$

(R

R

)