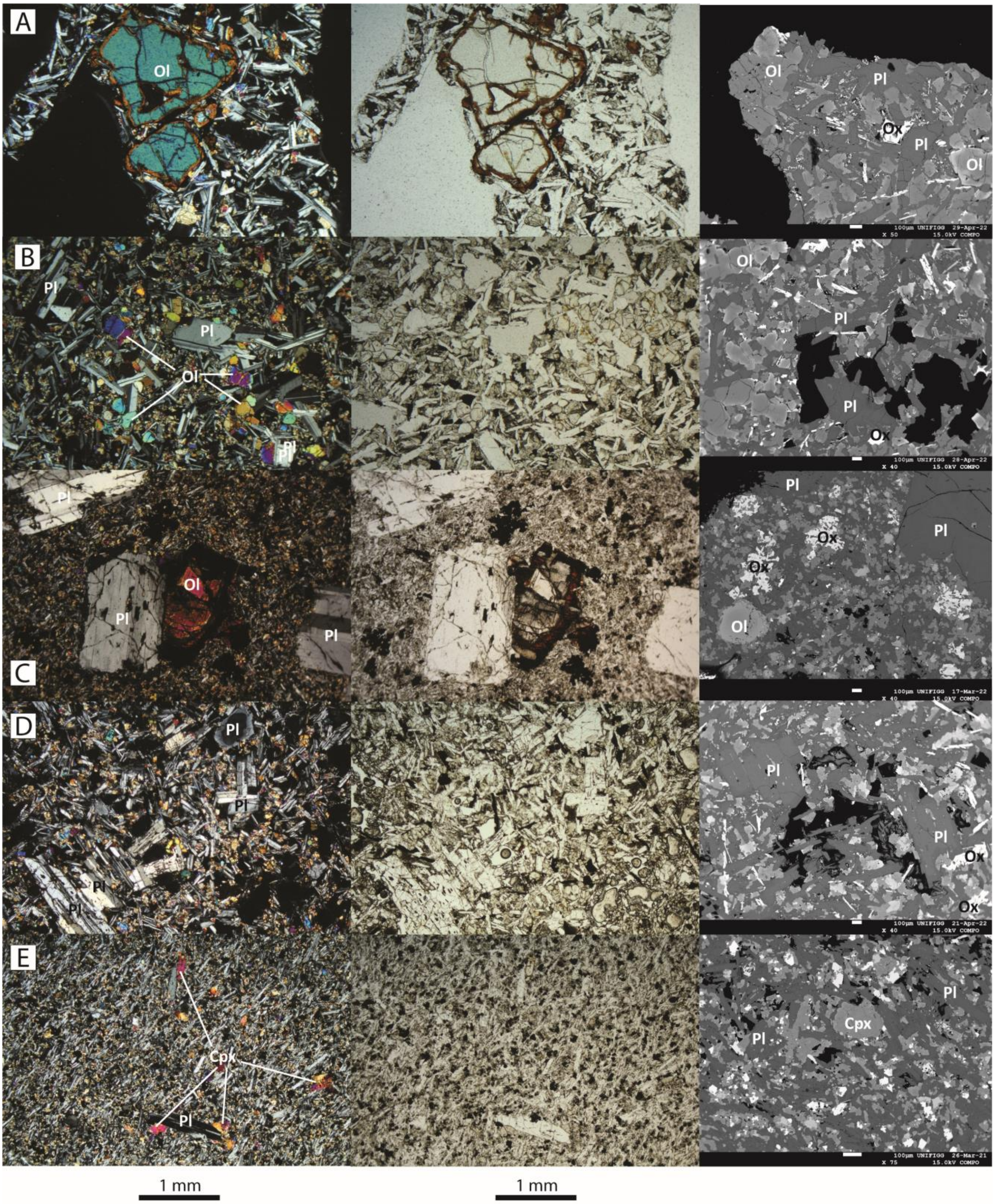
Fig. S4.1. Transmitted light petrographic (PPL and XPL) and SEM images (from left to right) of US and CAG. (a,b) US high-MgO samples. (c-e) US low-MgO samples. (f) CAG high-MgO samples (g-l) CAG low-MgO samples. Pl, plagioclase; Cpx, clinopyroxene; Ol olivine; Ox, Fe-Ti oxides. The red dashed lines mark the groundmass variations. Note that for the SEM images the white bar at the bottom of each picture is always 100 µm.



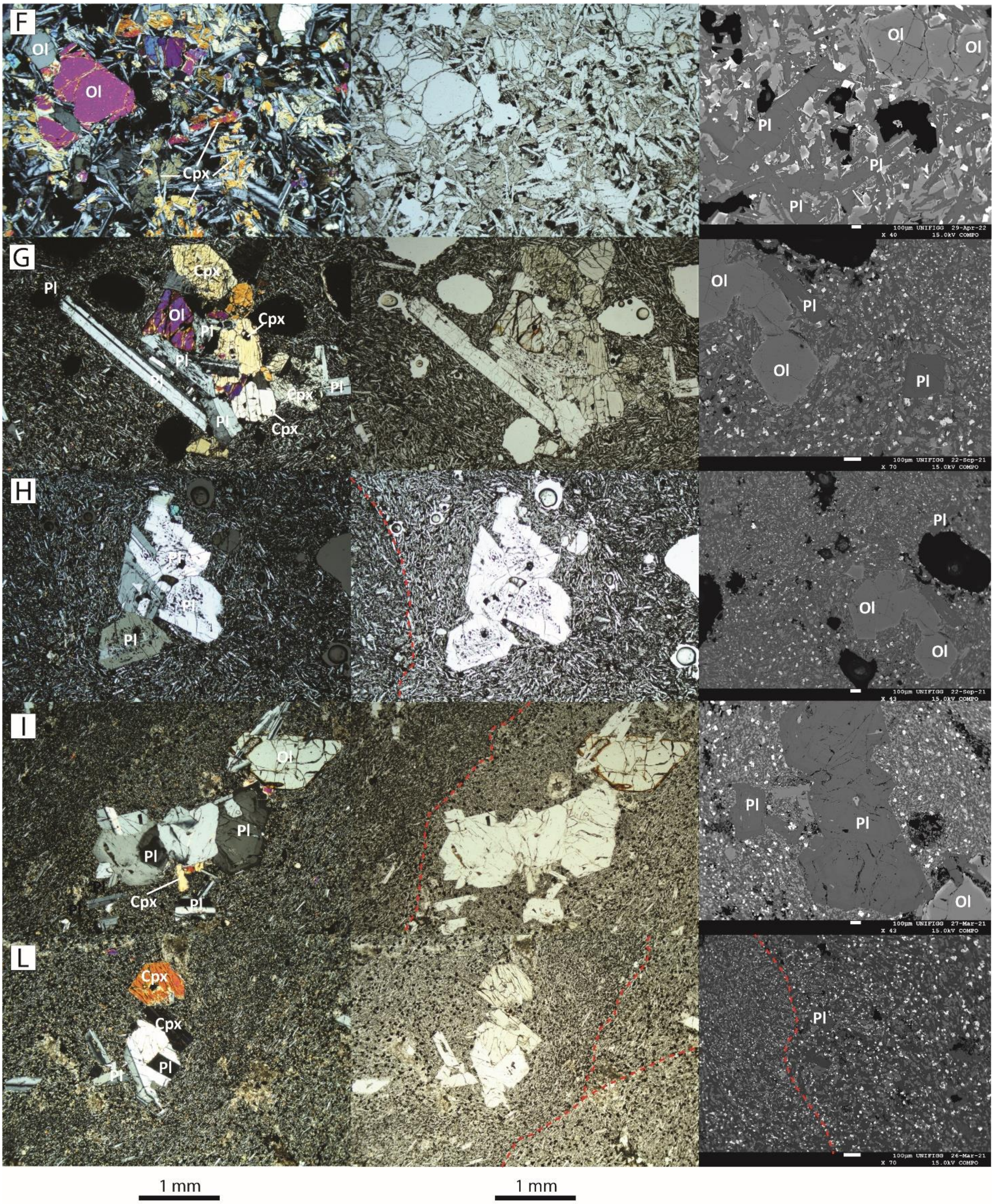

F
Ol
Ol
Cpx
Ol
Ol
Pl
Pl
Pl
G
Pl
Cpx
Ol
Pl
Cpx
Pl
Pl
Pl
Cpx
Pl
Cpx
Ol
Pl
Ol
Pl
H
Pl
Pl
Pl
Pl
Ol
Ol
I
Ol
Pl
Pl
Pl
Cpx
Pl
Pl
Pl
Ol
L
Cpx
Cpx
Pl
Pl
Pl
1 mm
1 mm

Fig. S4.2 Classification diagram for Fe-Ti oxide minerals. The compositions lie along the magnetite-ulvospinel (Fe_3O_4 - Fe_2TiO_4) and hematite-ilmenite (Fe_2O_3 - $FeTiO_3$) solid-solution boundary. The EPMA data are listed in Tab. S2.1.

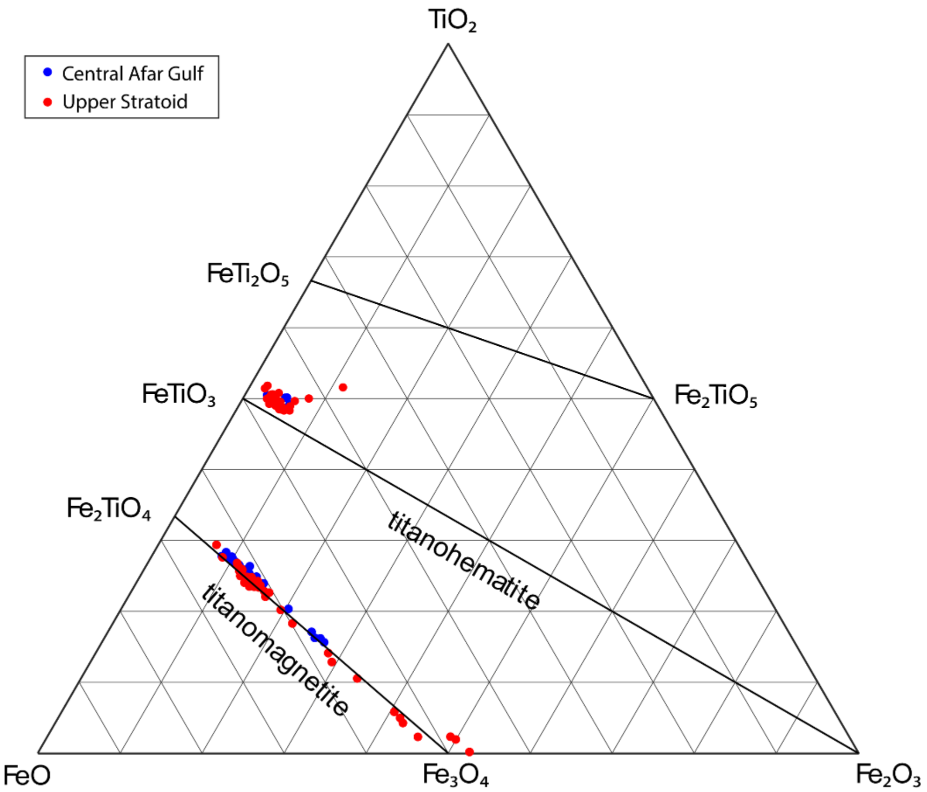
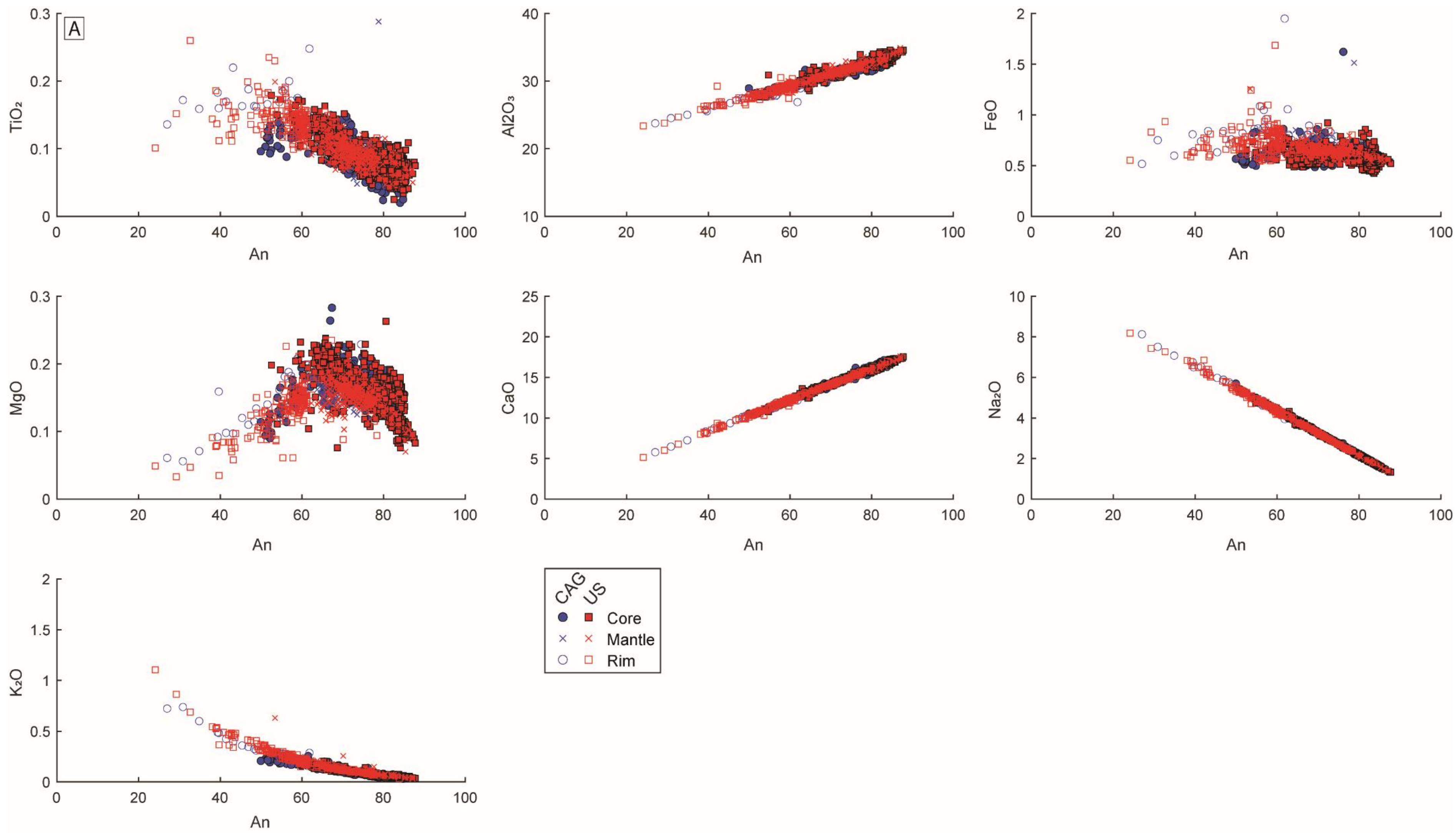
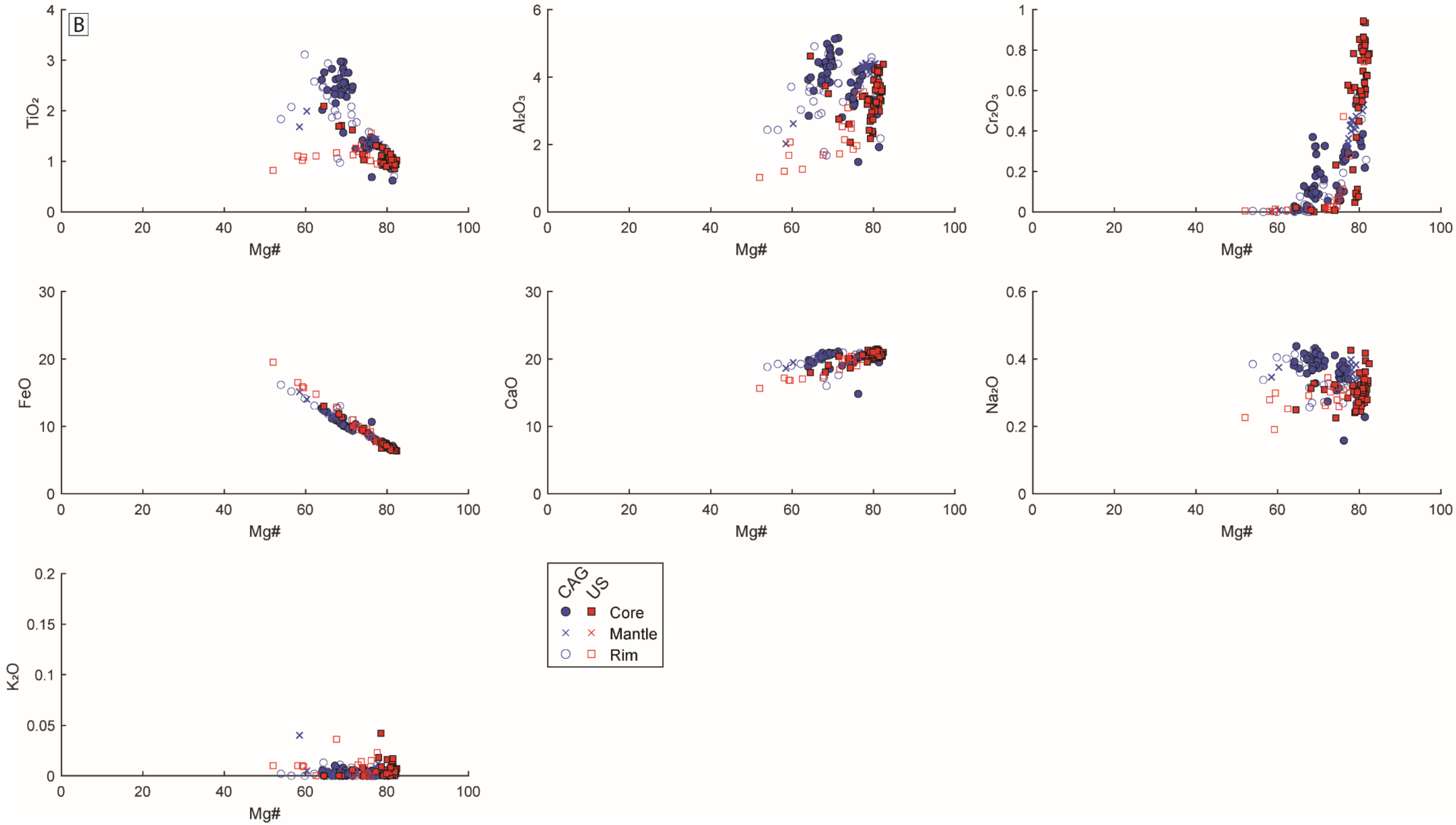


Fig. S4.3 EPMA variation diagrams of US and CAG. a) Variation of major and trace element concentrations vs An contents of Upper Stratoid and Central Afar Gulf plagioclase. b) Variation of major and trace element concentrations vs Mg# contents of Upper Stratoid and Central Afar Gulf clinopyroxene. c) Variation of major and trace element concentrations vs Fo contents of Upper Stratoid and Central Afar Gulf olivine. The EPMA data are listed in Tab. S2.1. (next page).


A
TiO₂
Al2O₃
FeO
MgO
CaO
Na₂O
K₂O
An
CAG
US
Core
Mantle
Rim



B
TiO₂
Al₂O₃
Cr₂O₃
FeO
CaO
Na₂O
K₂O
Mg#
CAG
US
Core
Mantle
Rim

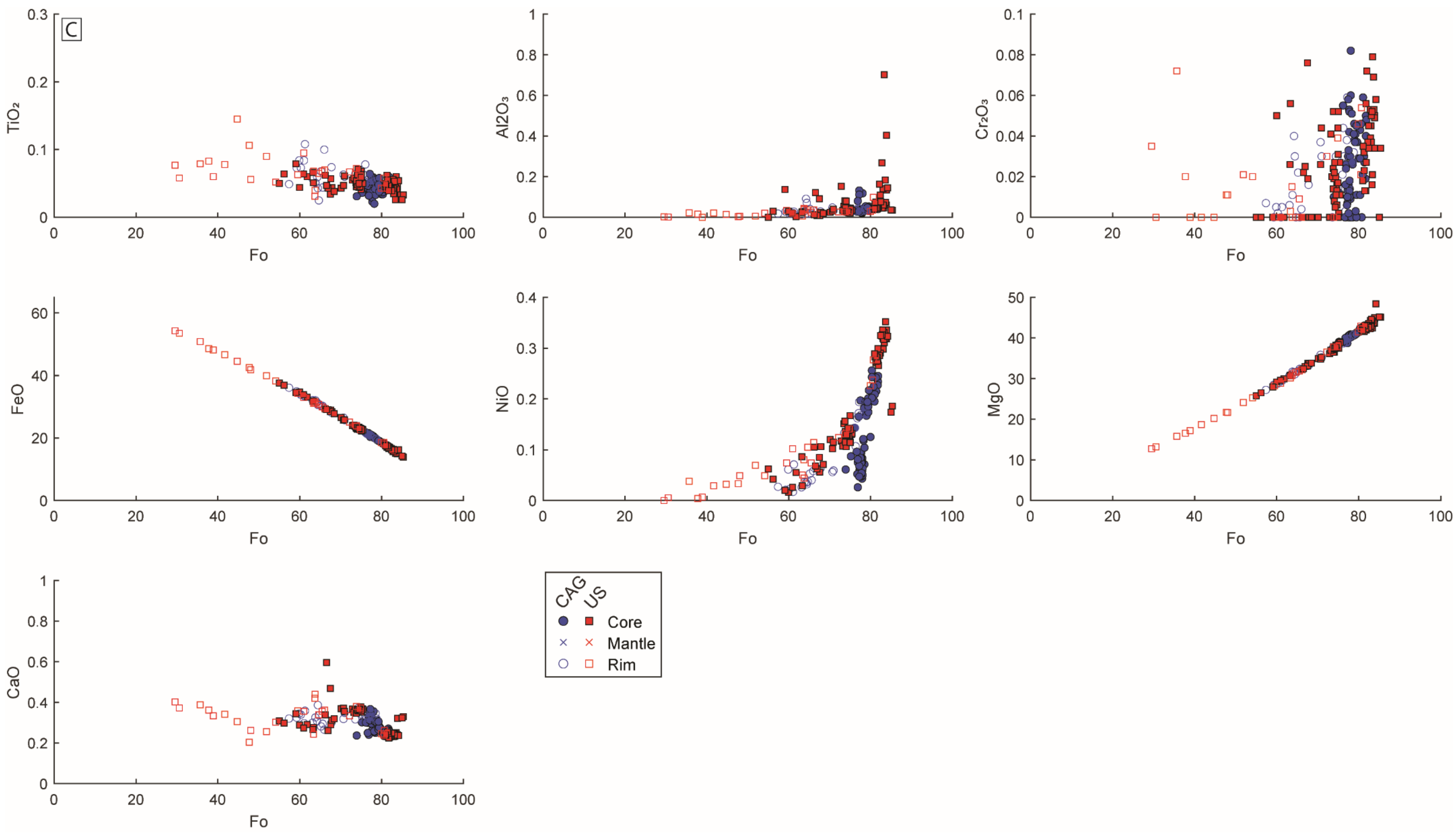
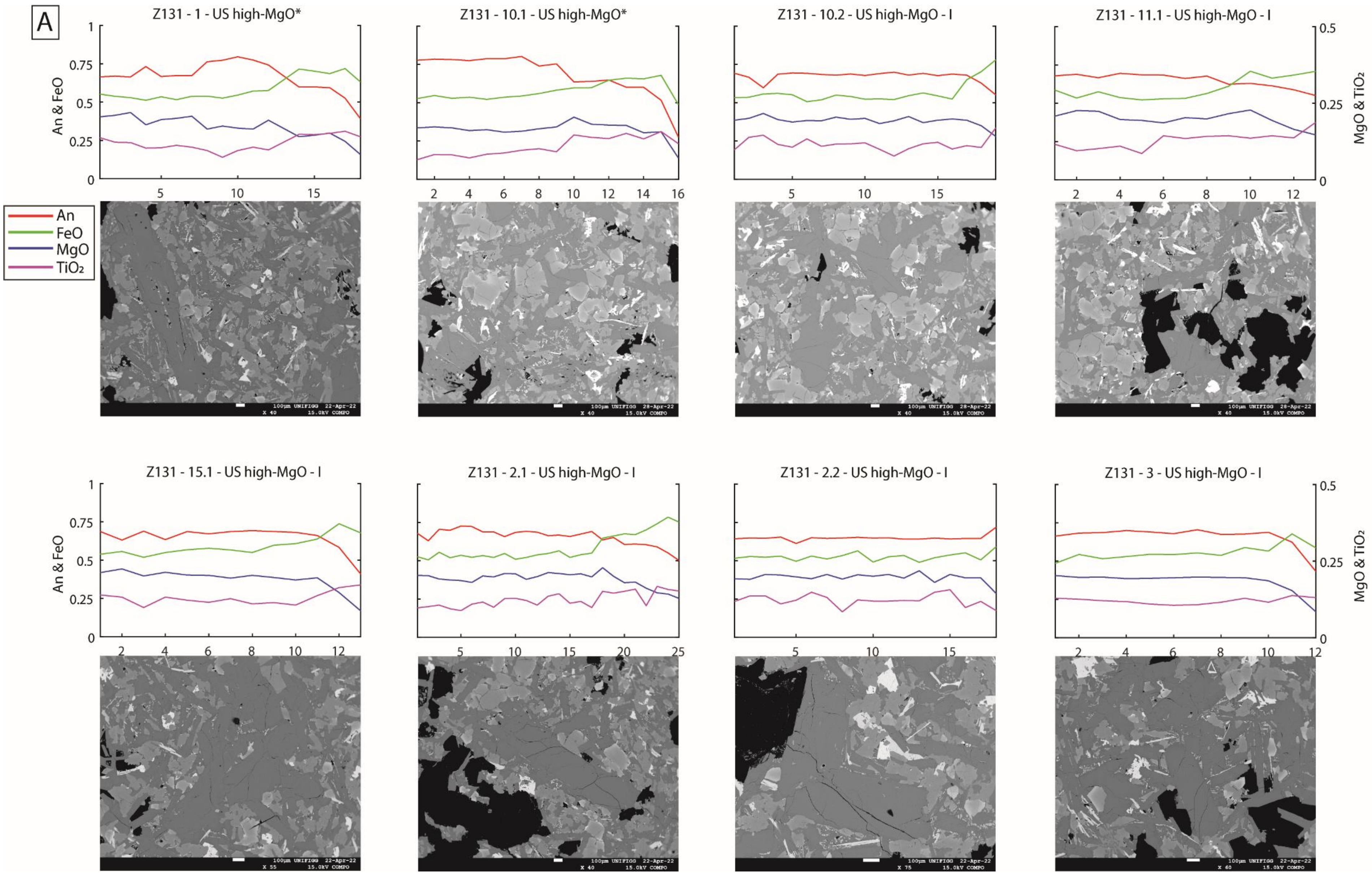
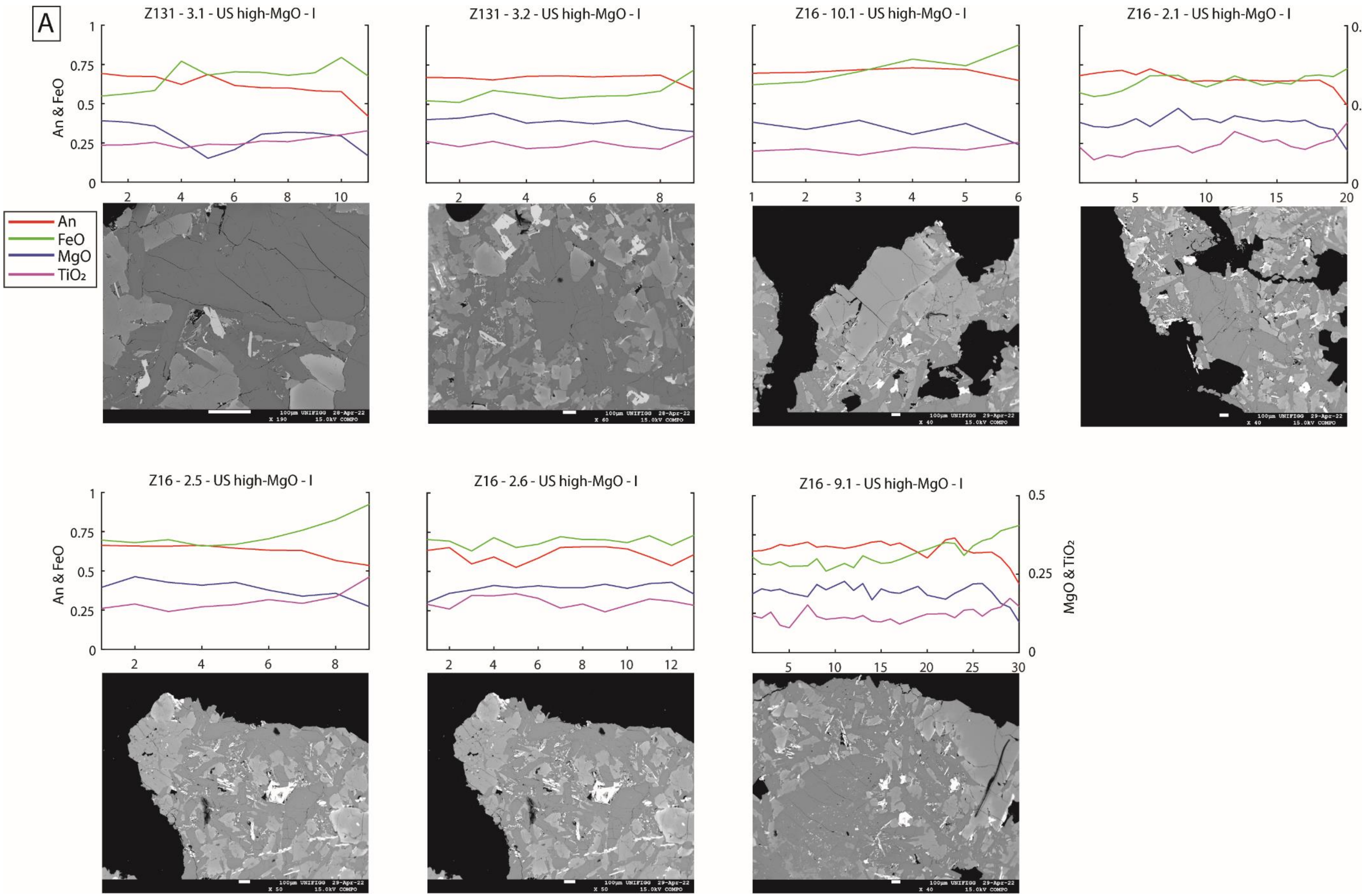
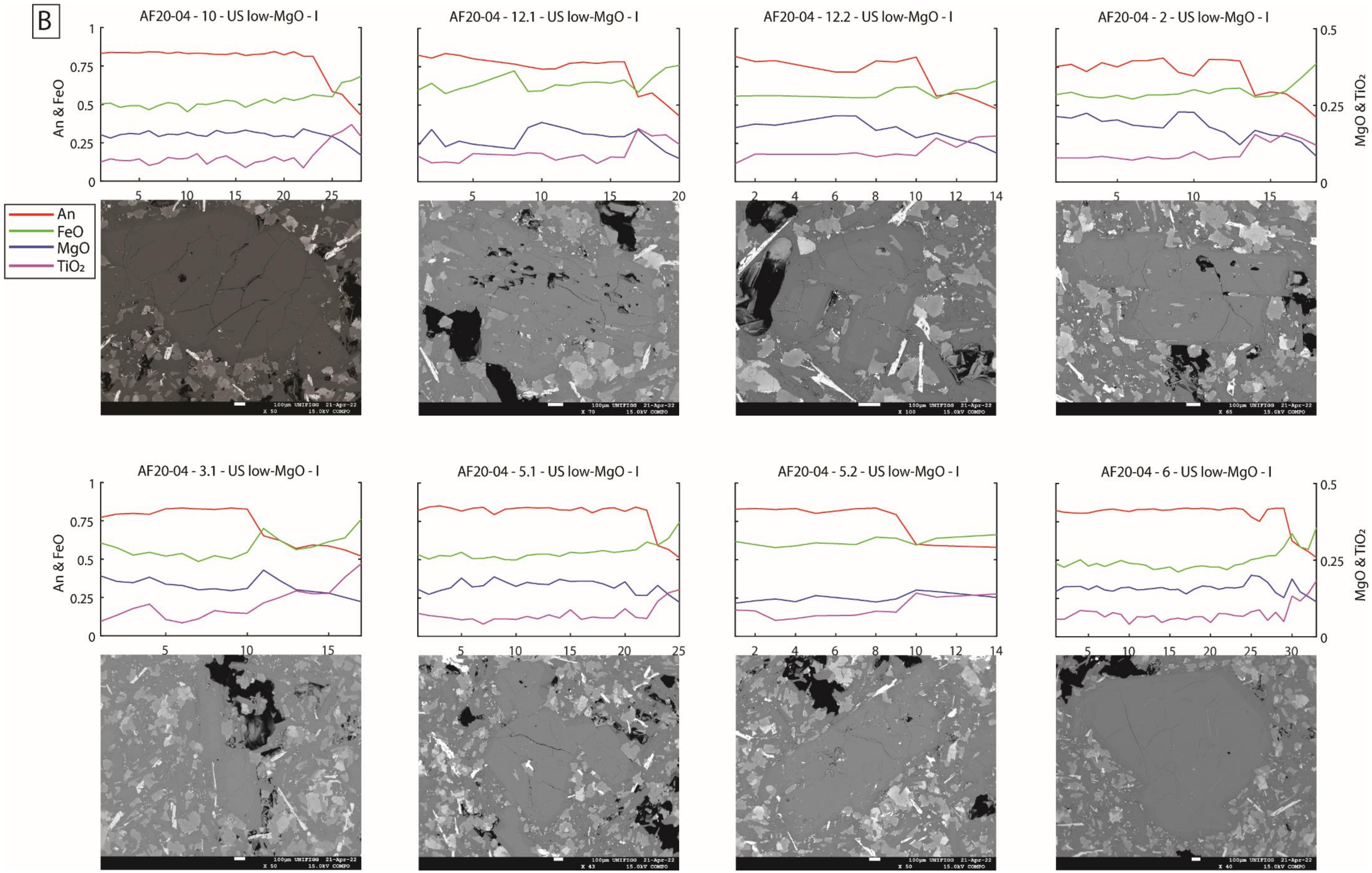
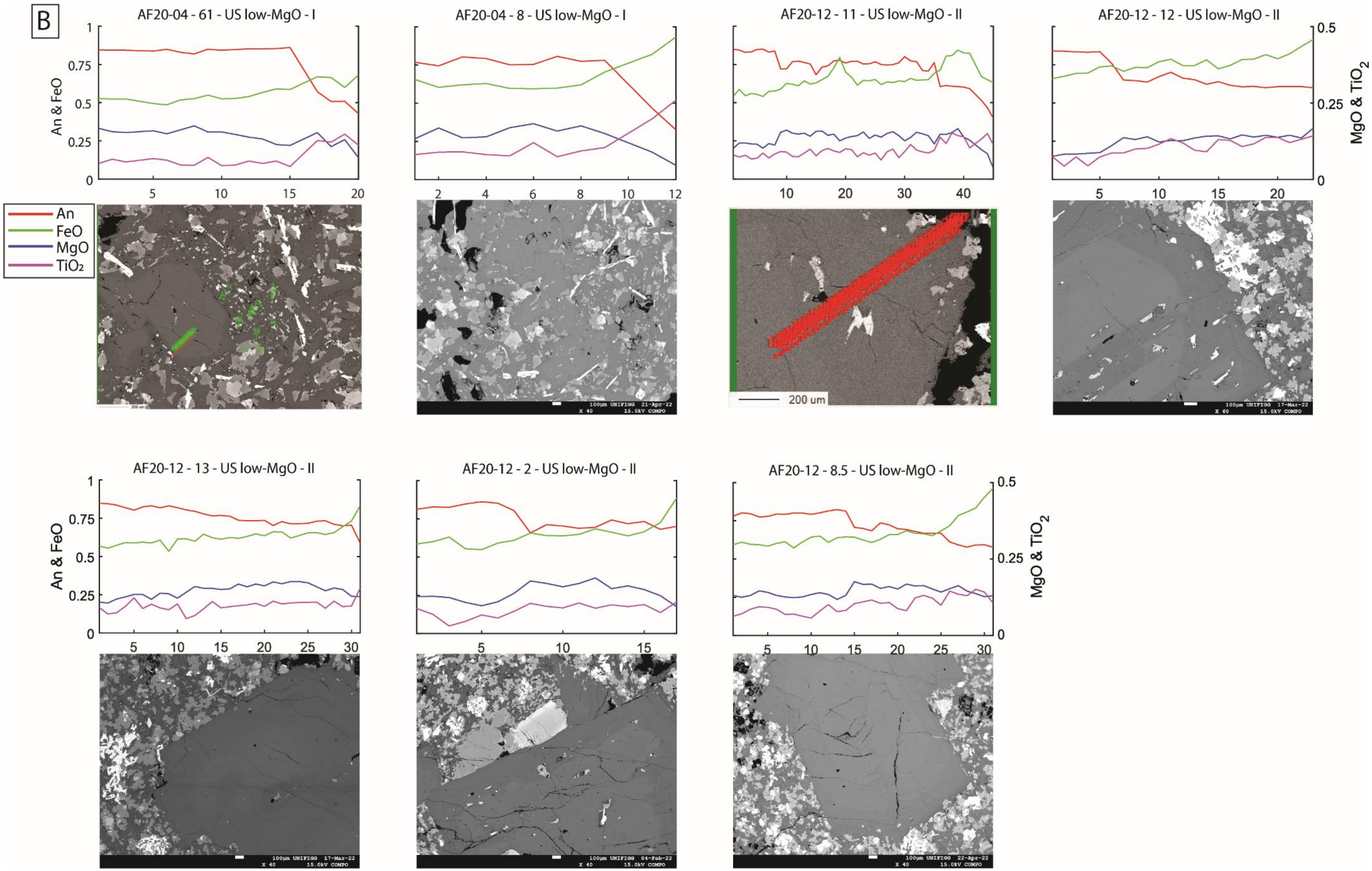

C
TiO2
Al2O3
Cr2O3
FeO
NiO
MgO
CaO
Fo
CAG
US
Core
Mantle
Rim

*Fig. S4.4 Compositional profiles of anorthite content, FeO, TiO_2 and MgO concentration with relative SEM pictures for: (a) US high-MgO sample; (b) US low-MgO samples; (c) CAG high-MgO sample; (d) CAG low-MgO samples. Each profile is titled with the sample name, the crystal analysis number, the Series name acronym, the low- or high-MgO group and the crystal typology number described in text. * mark the peculiar crystals not classified in any topology. The EPMA data are listed in Tab. S2.1. (next page).*

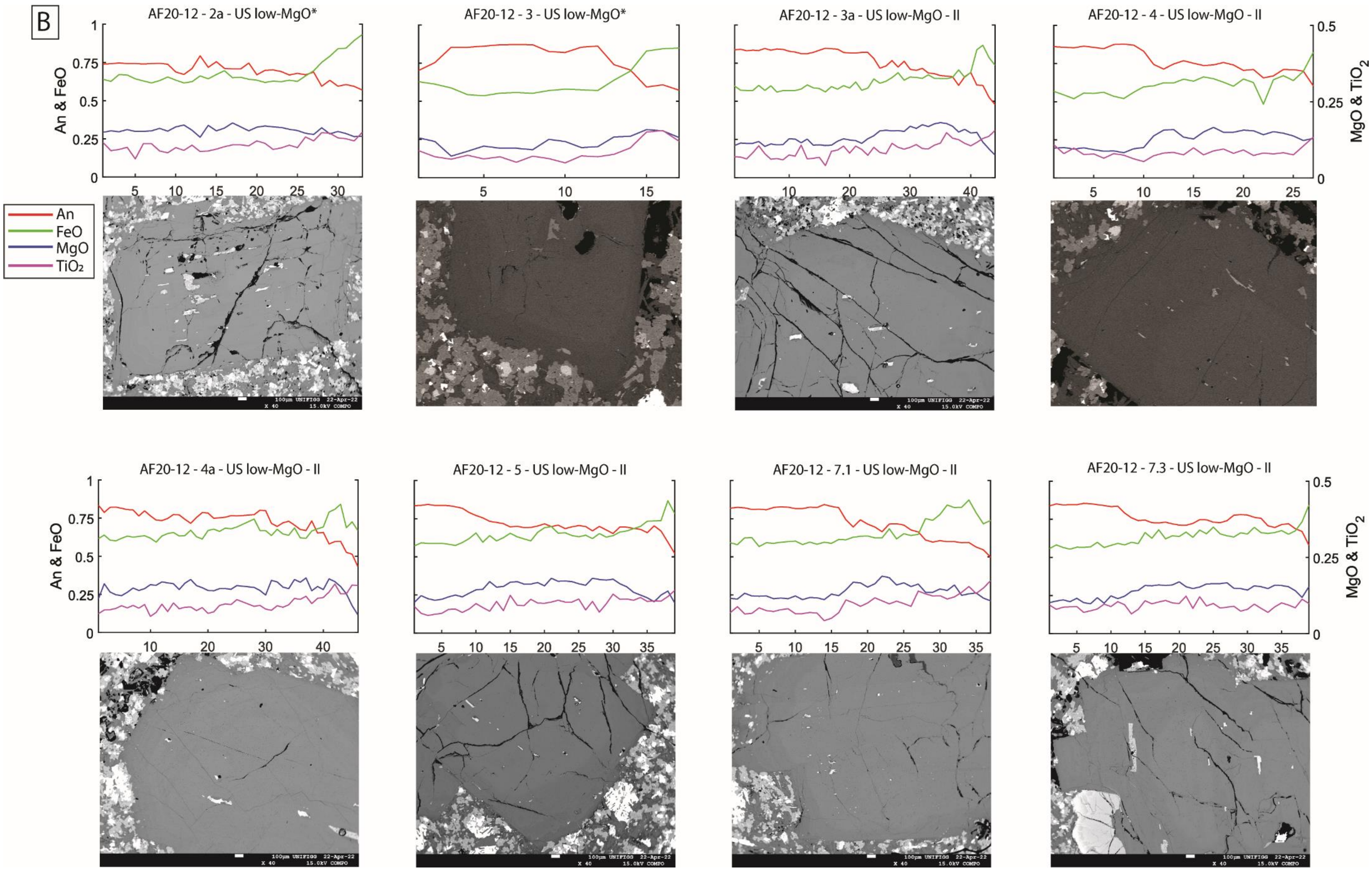

A
Z131 - 1 - US high-MgO*
Z131 - 10.1 - US high-MgO*
Z131 - 10.2 - US high-MgO - I
Z131 - 11.1 - US high-MgO - I
Z131 - 15.1 - US high-MgO - I
Z131 - 2.1 - US high-MgO - I
Z131 - 2.2 - US high-MgO - I
Z131 - 3 - US high-MgO - I
An & FeO
MgO & TiO₂
An
FeO
MgO
TiO₂


A
Z131 - 3.1 - US high-MgO - I
Z131 - 3.2 - US high-MgO - I
Z16 - 10.1 - US high-MgO - I
Z16 - 2.1 - US high-MgO - I
Z16 - 2.5 - US high-MgO - I
Z16 - 2.6 - US high-MgO - I
Z16 - 9.1 - US high-MgO - I
An & FeO
MgO & TiO₂
An
FeO
MgO
TiO₂

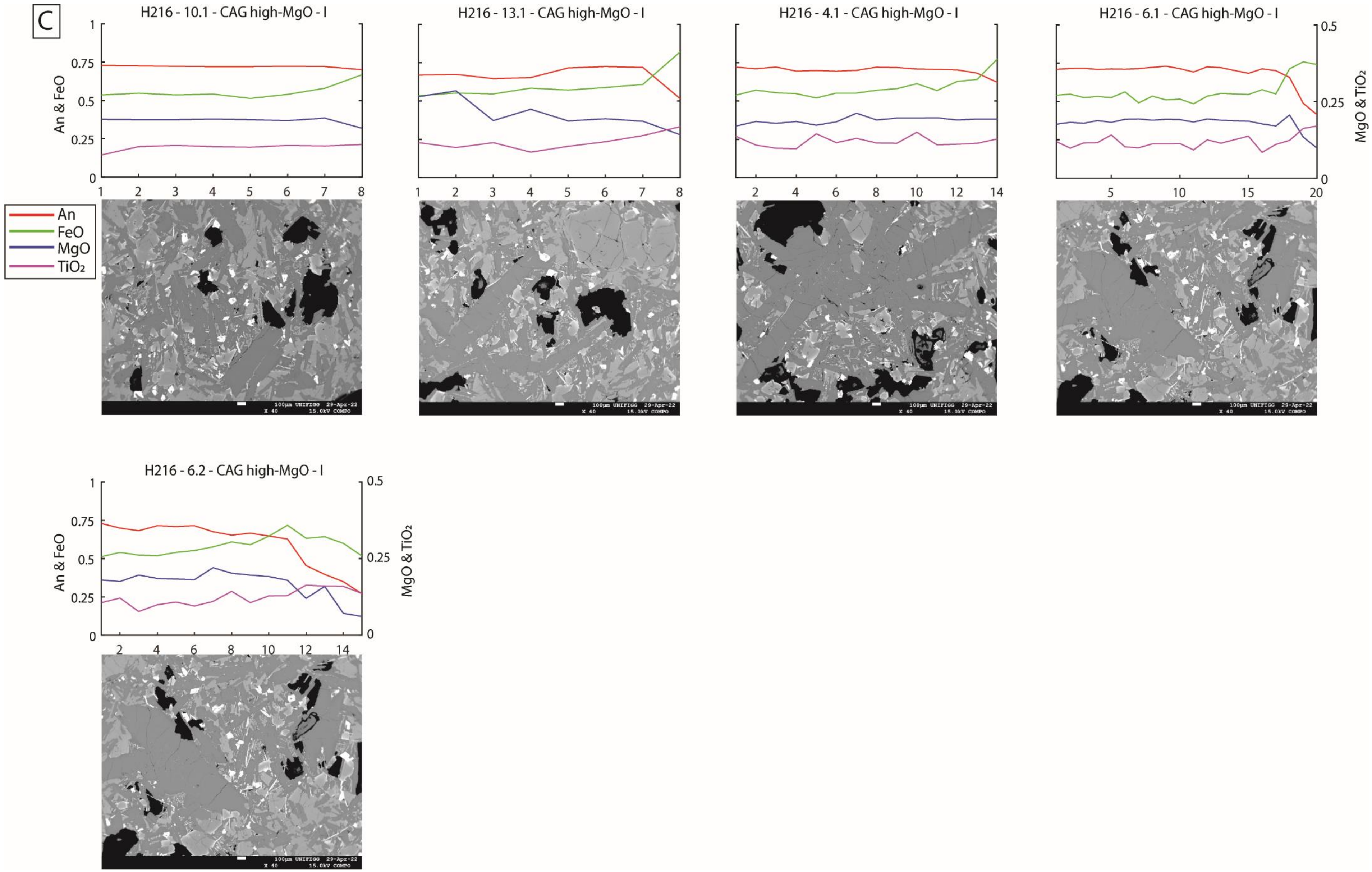

B
AF20-04 - 10 - US low-MgO - I
AF20-04 - 12.1 - US low-MgO - I
AF20-04 - 12.2 - US low-MgO - I
AF20-04 - 2 - US low-MgO - I
AF20-04 - 3.1 - US low-MgO - I
AF20-04 - 5.1 - US low-MgO - I
AF20-04 - 5.2 - US low-MgO - I
AF20-04 - 6 - US low-MgO - I
An & FeO
MgO & TiO₂
An
FeO
MgO
TiO₂



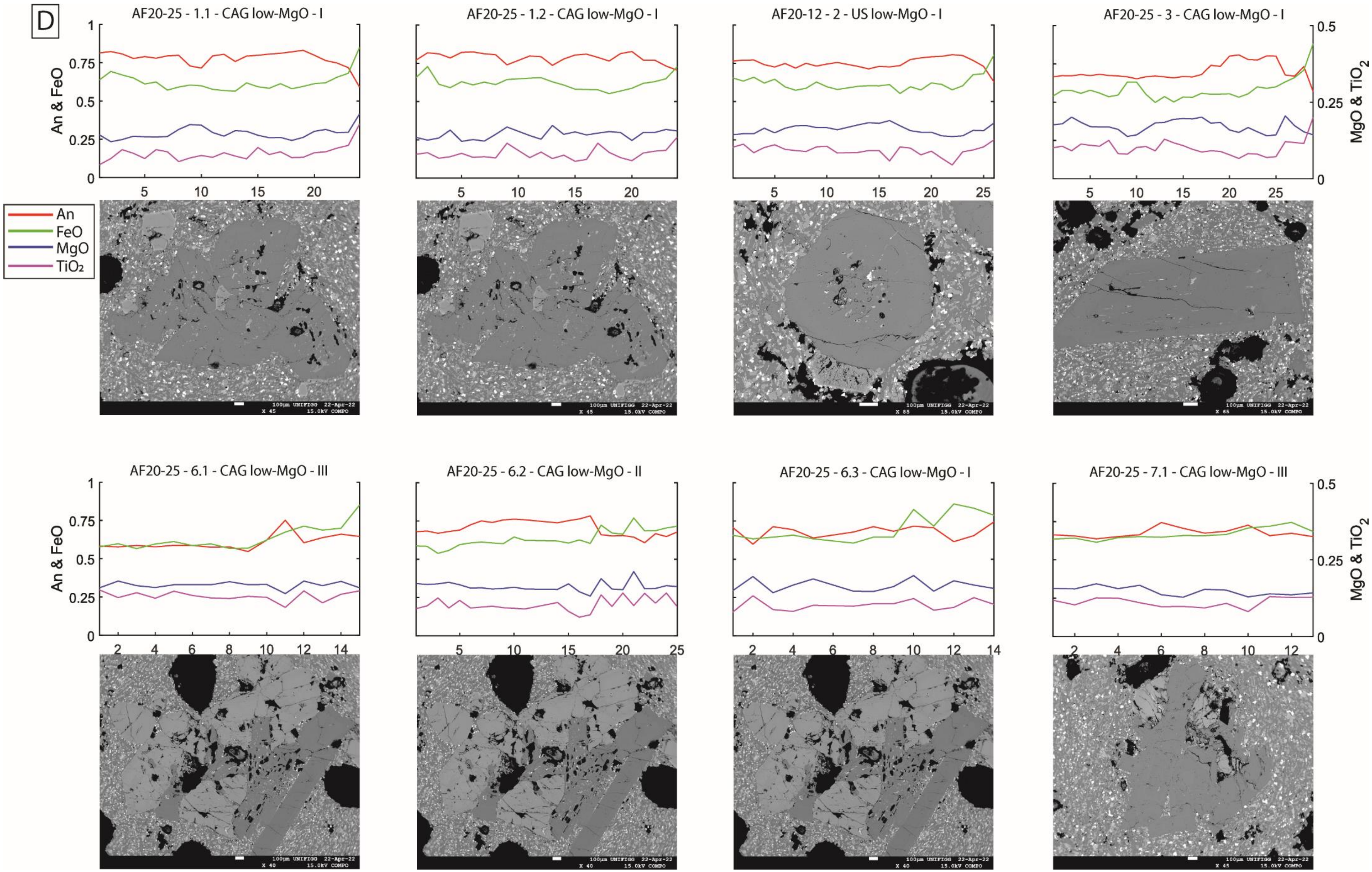
B
AF20-04 - 61 - US low-MgO - I
AF20-04 - 8 - US low-MgO - I
AF20-12 - 11 - US low-MgO - II
AF20-12 - 12 - US low-MgO - II
AF20-12 - 13 - US low-MgO - II
AF20-12 - 2 - US low-MgO - II
AF20-12 - 8.5 - US low-MgO - II
An & FeO
MgO & TiO2
An
FeO
MgO
TiO2
200 um



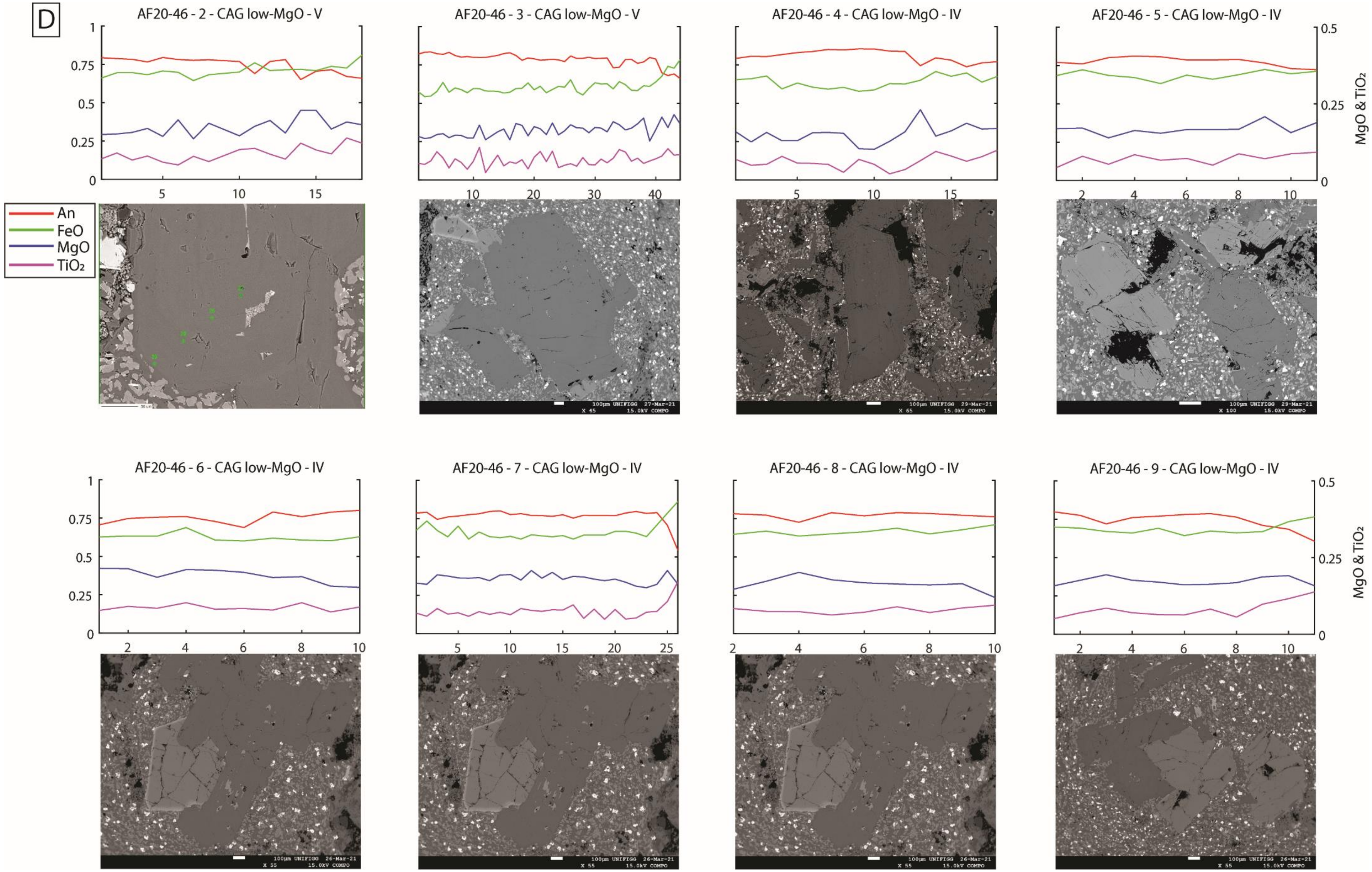
B
AF20-12 - 2a - US low-MgO*
AF20-12 - 3 - US low-MgO*
AF20-12 - 3a - US low-MgO - II
AF20-12 - 4 - US low-MgO - II
AF20-12 - 4a - US low-MgO - II
AF20-12 - 5 - US low-MgO - II
AF20-12 - 7.1 - US low-MgO - II
AF20-12 - 7.3 - US low-MgO - II
An & FeO
MgO & TiO2
An
FeO
MgO
TiO2



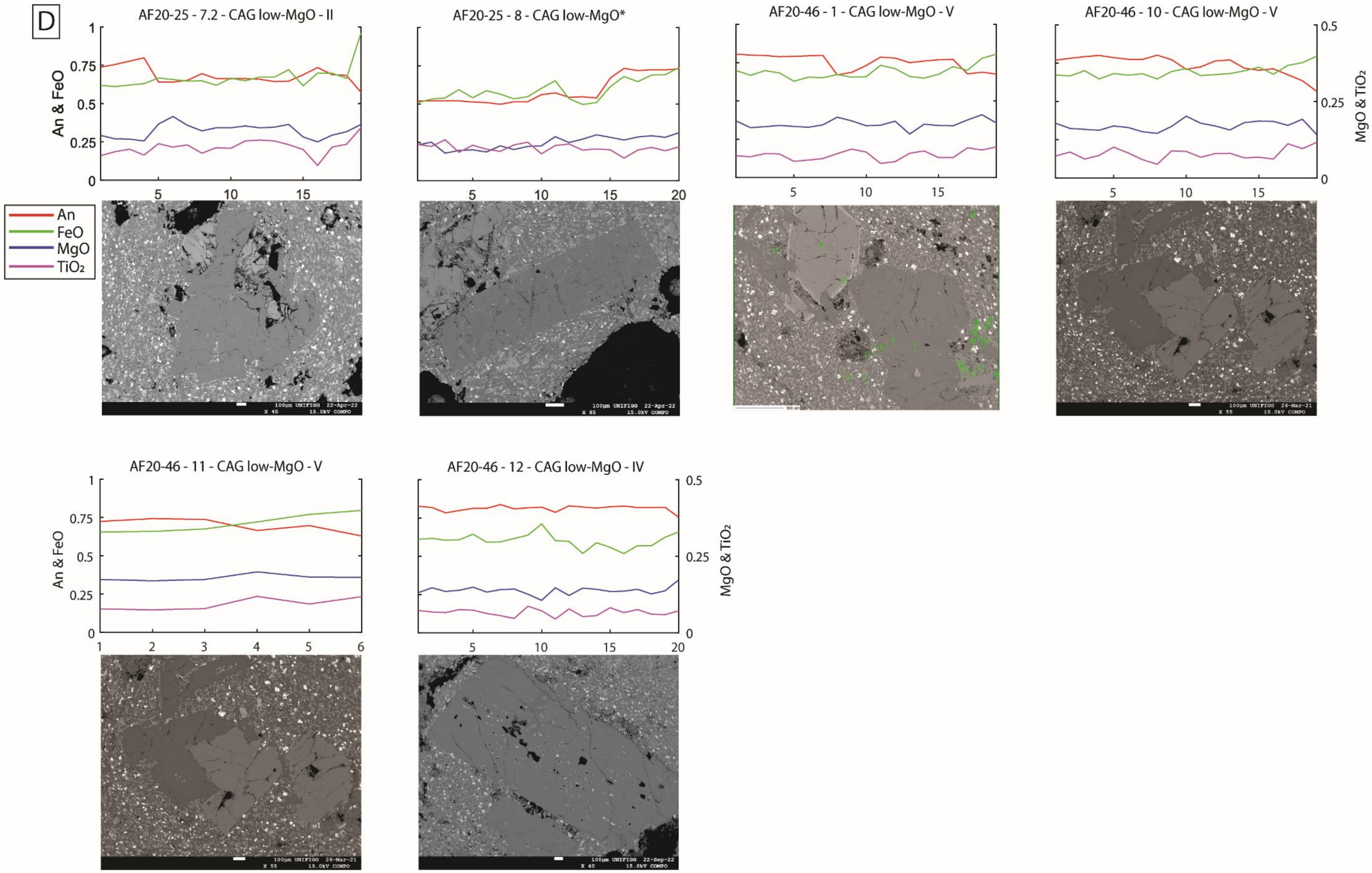
C
H216 - 10.1 - CAG high-MgO - I
H216 - 13.1 - CAG high-MgO - I
H216 - 4.1 - CAG high-MgO - I
H216 - 6.1 - CAG high-MgO - I
H216 - 6.2 - CAG high-MgO - I
An & FeO
MgO & TiO2
An
FeO
MgO
TiO2



D
AF20-25 - 1.1 - CAG low-MgO - I
AF20-25 - 1.2 - CAG low-MgO - I
AF20-12 - 2 - US low-MgO - I
AF20-25 - 3 - CAG low-MgO - I
AF20-25 - 6.1 - CAG low-MgO - III
AF20-25 - 6.2 - CAG low-MgO - II
AF20-25 - 6.3 - CAG low-MgO - I
AF20-25 - 7.1 - CAG low-MgO - III
An & FeO
MgO & TiO2
An
FeO
MgO
TiO2

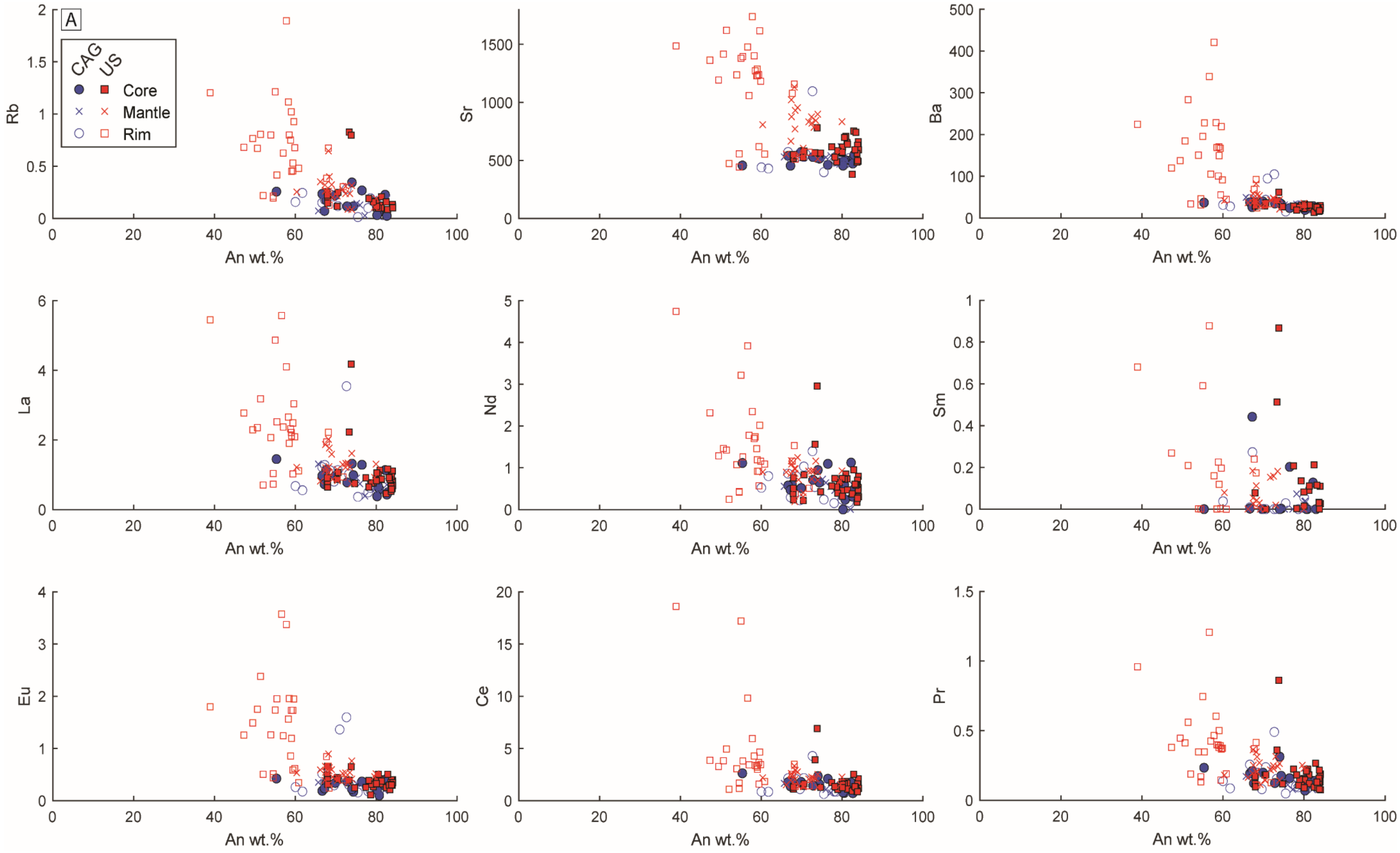


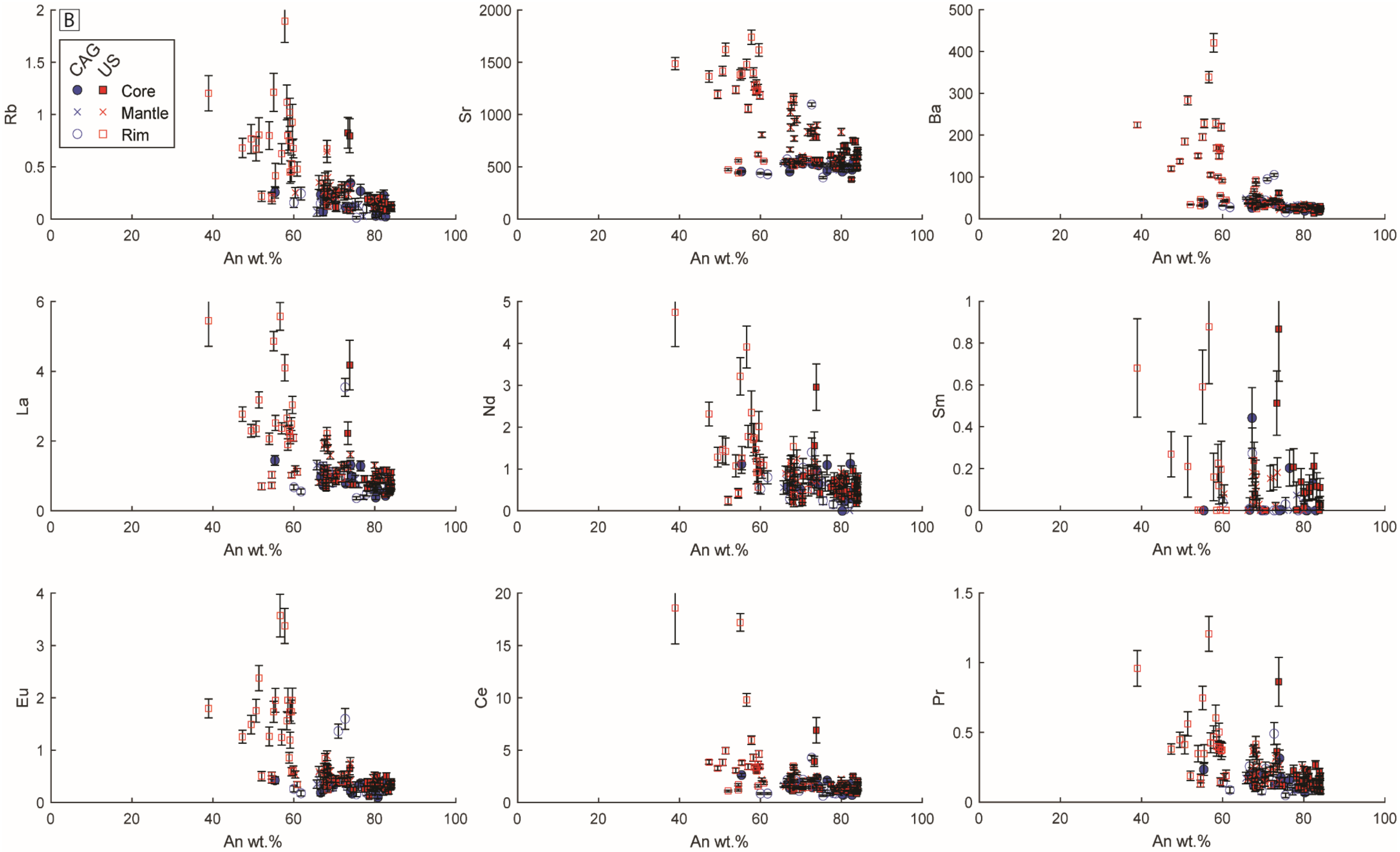
D
AF20-46 - 2 - CAG low-MgO - V
AF20-46 - 3 - CAG low-MgO - V
AF20-46 - 4 - CAG low-MgO - IV
AF20-46 - 5 - CAG low-MgO - IV
AF20-46 - 6 - CAG low-MgO - IV
AF20-46 - 7 - CAG low-MgO - IV
AF20-46 - 8 - CAG low-MgO - IV
AF20-46 - 9 - CAG low-MgO - IV
An
FeO
MgO
TiO_2
MgO & TiO_2



D
AF20-25 - 7.2 - CAG low-MgO - II
AF20-25 - 8 - CAG low-MgO*
AF20-46 - 1 - CAG low-MgO - V
AF20-46 - 10 - CAG low-MgO - V
AF20-46 - 11 - CAG low-MgO - V
AF20-46 - 12 - CAG low-MgO - IV
An & FeO
MgO & TiO2
An
FeO
MgO
TiO2

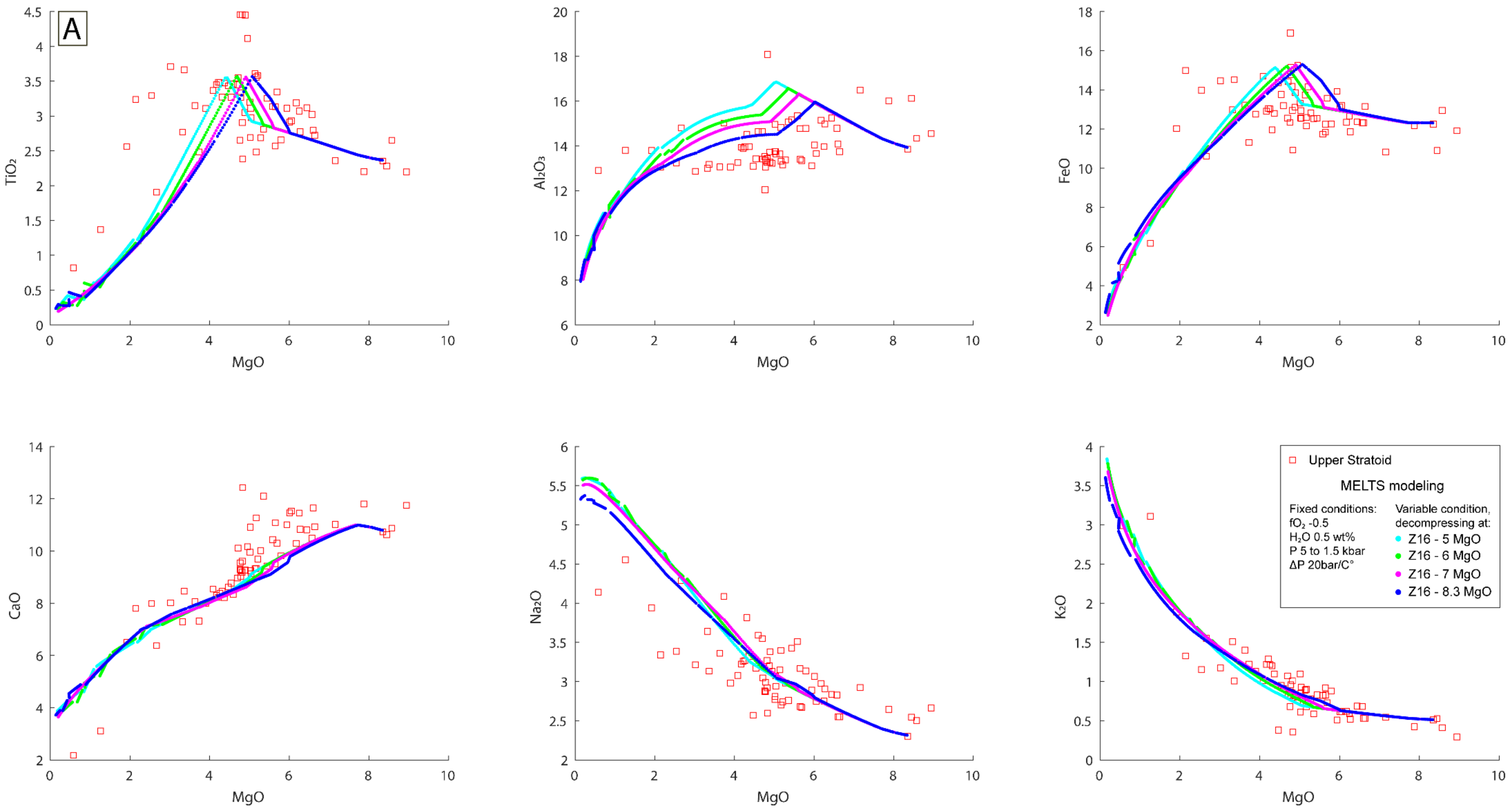
Fig. S4.5 a) Variation of all trace element concentrations vs An contents of Upper Stratoid and Central Afar Gulf plagioclase. b) Same as figure (a), with vertical bars representing 2σ standard deviations. The LA-ICP-MS data are listed in Tab. S2.1. (next page).

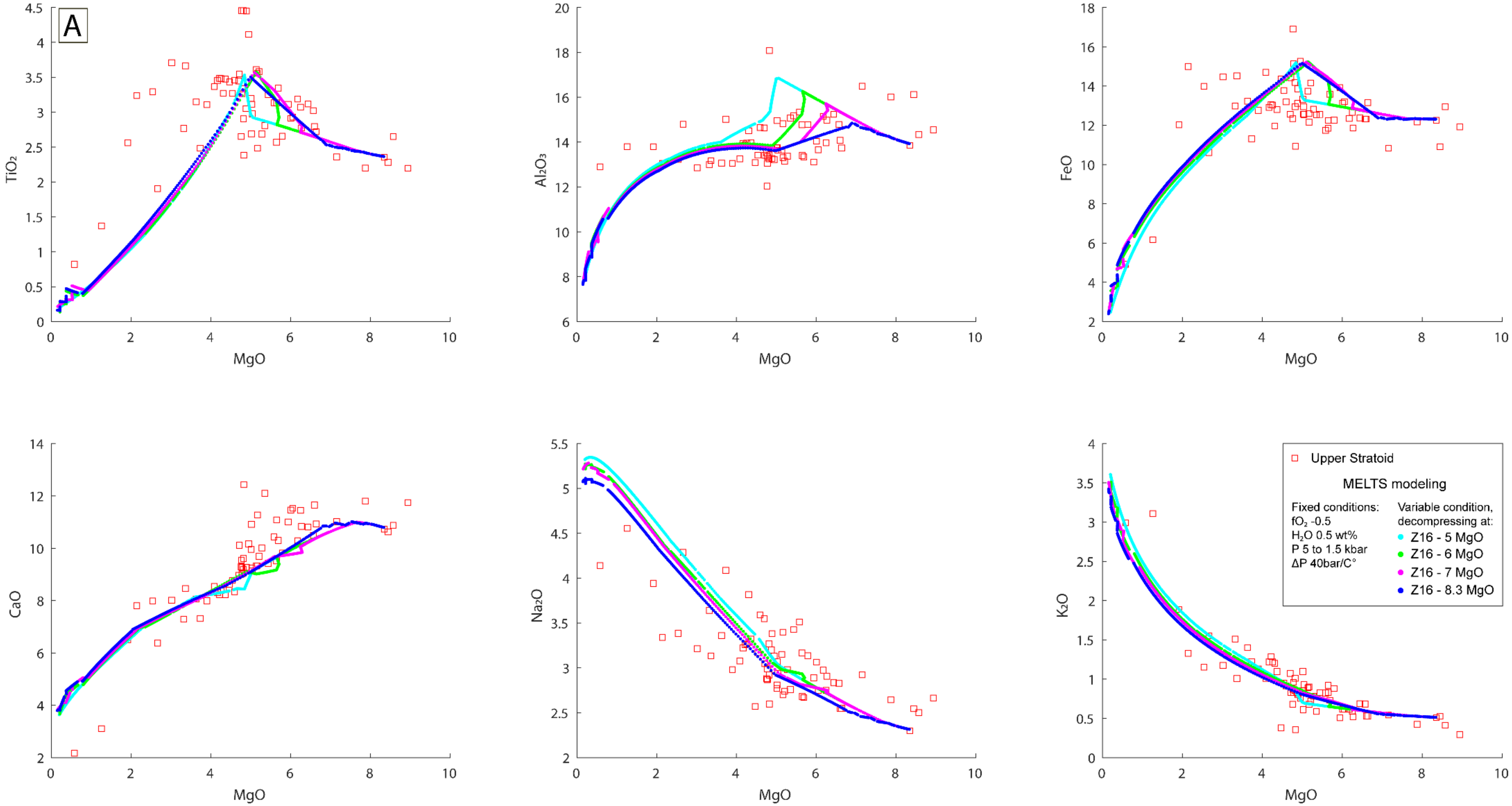

A
CAG
US
Core
Mantle
Rim
Rb
Sr
Ba
La
Nd
Sm
Eu
Ce
Pr
An wt.%



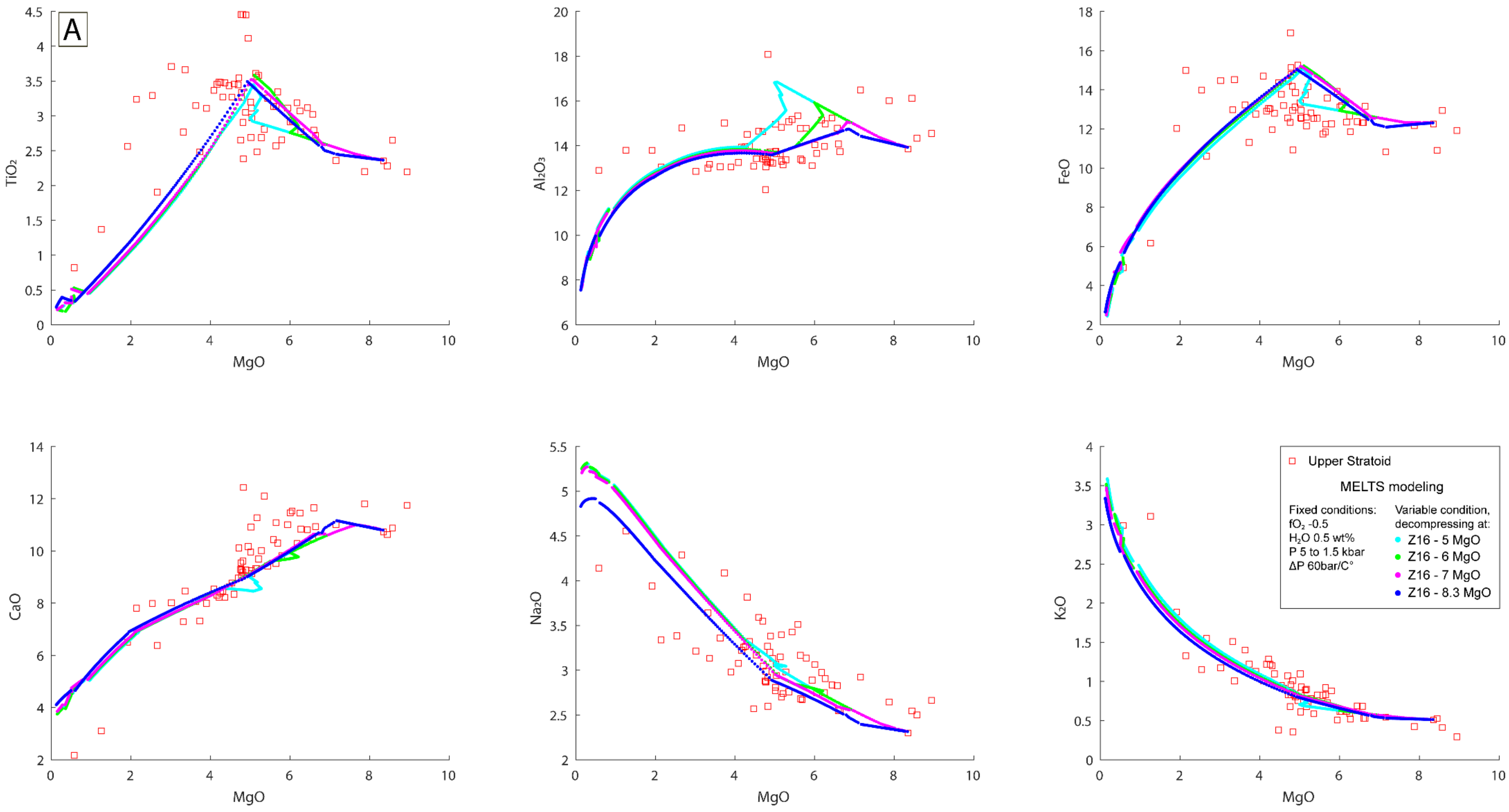
B
CAG
US
Core
Mantle
Rim
Rb
Sr
Ba
La
Nd
Sm
Eu
Ce
Pr
An wt.%

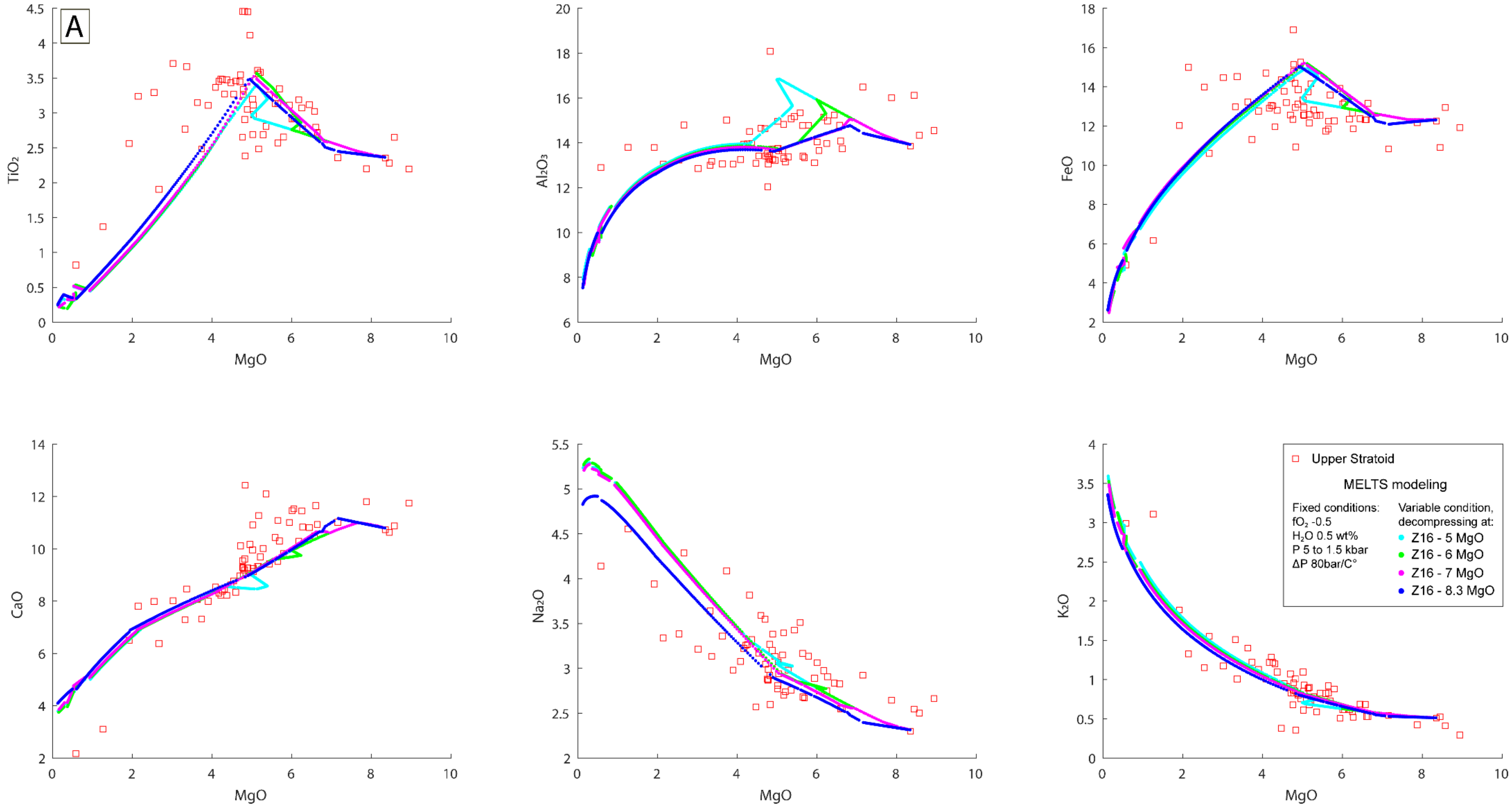
Fig. S4.6 a-d) Modelled liquid line of descent for the Upper Stratoid Series major elements (wt%) by means of rhyolite-MELTS, (Asimow et al., 2004; Ghiorso and Sack, 1995). a) Fixed oxygen fugacity (QFM -0.5), water content (0.5 wt.%) and initial and final pressure (5-1.5 kbar). Variable ΔP (20, 40, 60, 80 bar/C°) and degree of evolution reached by magma when it started to decompress (MgO wt% 5-8.3). b) Fixed oxygen fugacity (QFM -1), water content (1.5 wt.%) and initial and final pressure (5-1.5 kbar). Variable ΔP (20, 40g, 60, 80 bar/C°) and degree of evolution reached by magma when it started to decompress (MgO wt% 5-8.3). c) Fixed oxygen fugacity (QFM -0.5), water content (1.5 wt.%) and initial and final pressure (5-1.5 kbar). Variable ΔP (20, 40g, 60, 80 bar/C°) and degree of evolution reached by magma when it started to decompress (MgO wt% 5-8.3). d) Fixed oxygen fugacity (QFM -1), water content (0.5 wt.%) and initial and final pressure (5-1.5 kbar). Variable ΔP (20, 40g, 60, 80 bar/C°) and degree of evolution reached by magma when it started to decompress (MgO wt% 5-8.3). Data are from this work, Feyissa et al. (2019) and Barberi and Santacroce (1980). (next page)

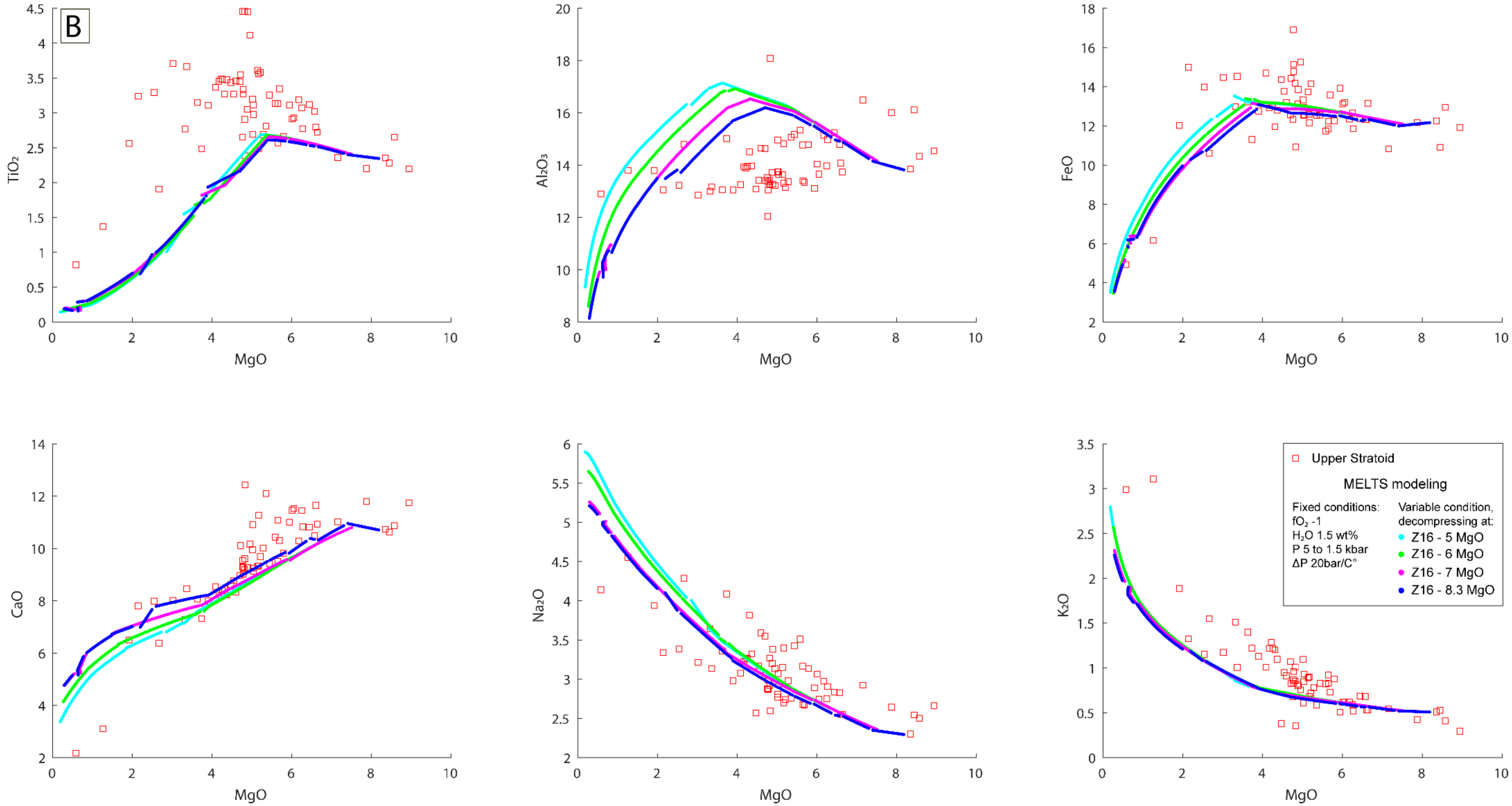

A
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -0.5
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 20bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

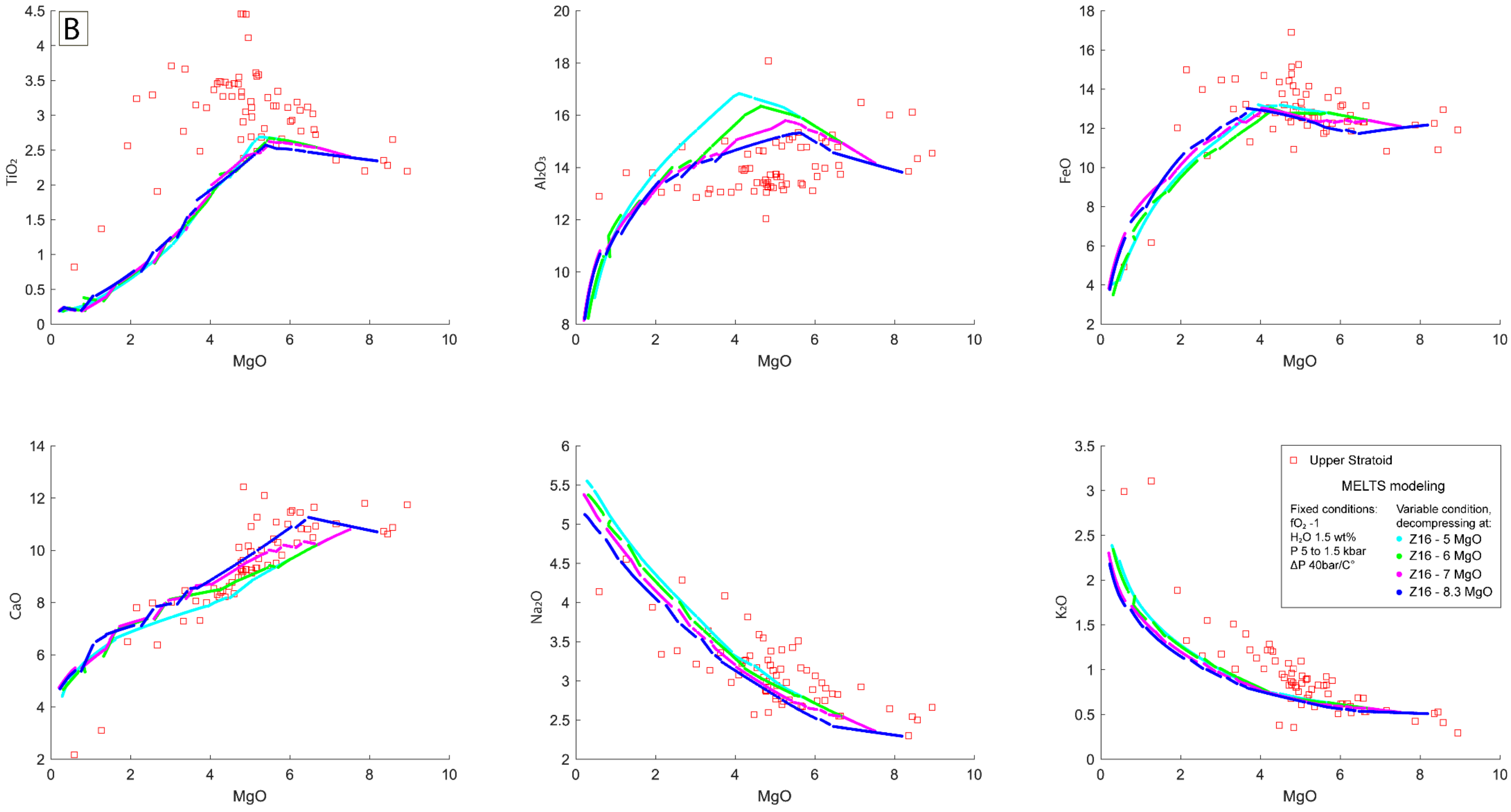


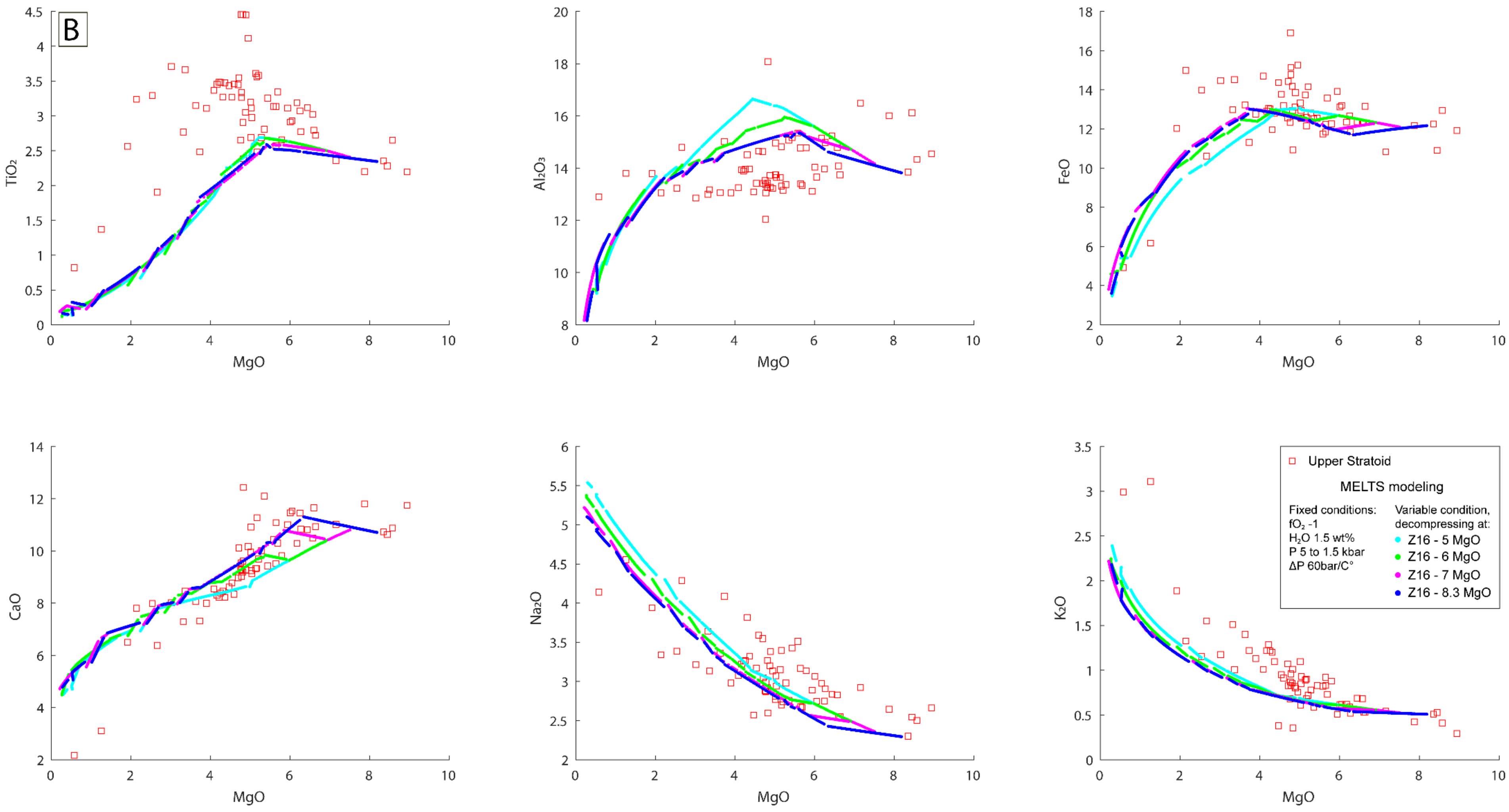
A
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -0.5
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 40bar/C°
Variable condition,
decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO


A
TiO_2
Al_2O_3
FeO
CaO
Na_2O
K_2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO_2 -0.5
H_2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 60bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

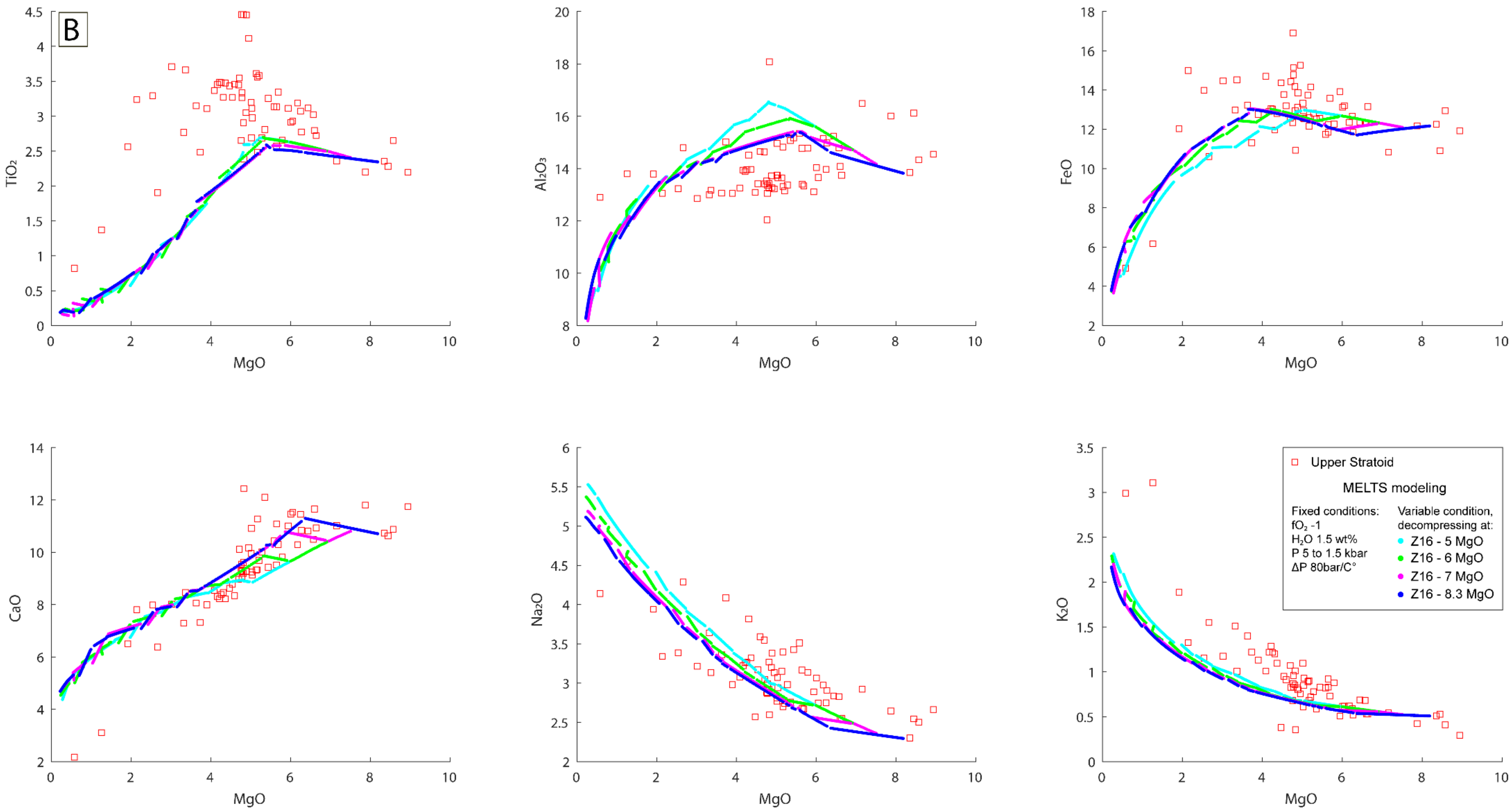

A
TiO₂
Al₂O₃
FeO
CaO
Na₂O
K₂O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO₂ -0.5
H₂O 0.5 wt%
P 5 to 1.5 kbar
ΔP 80bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

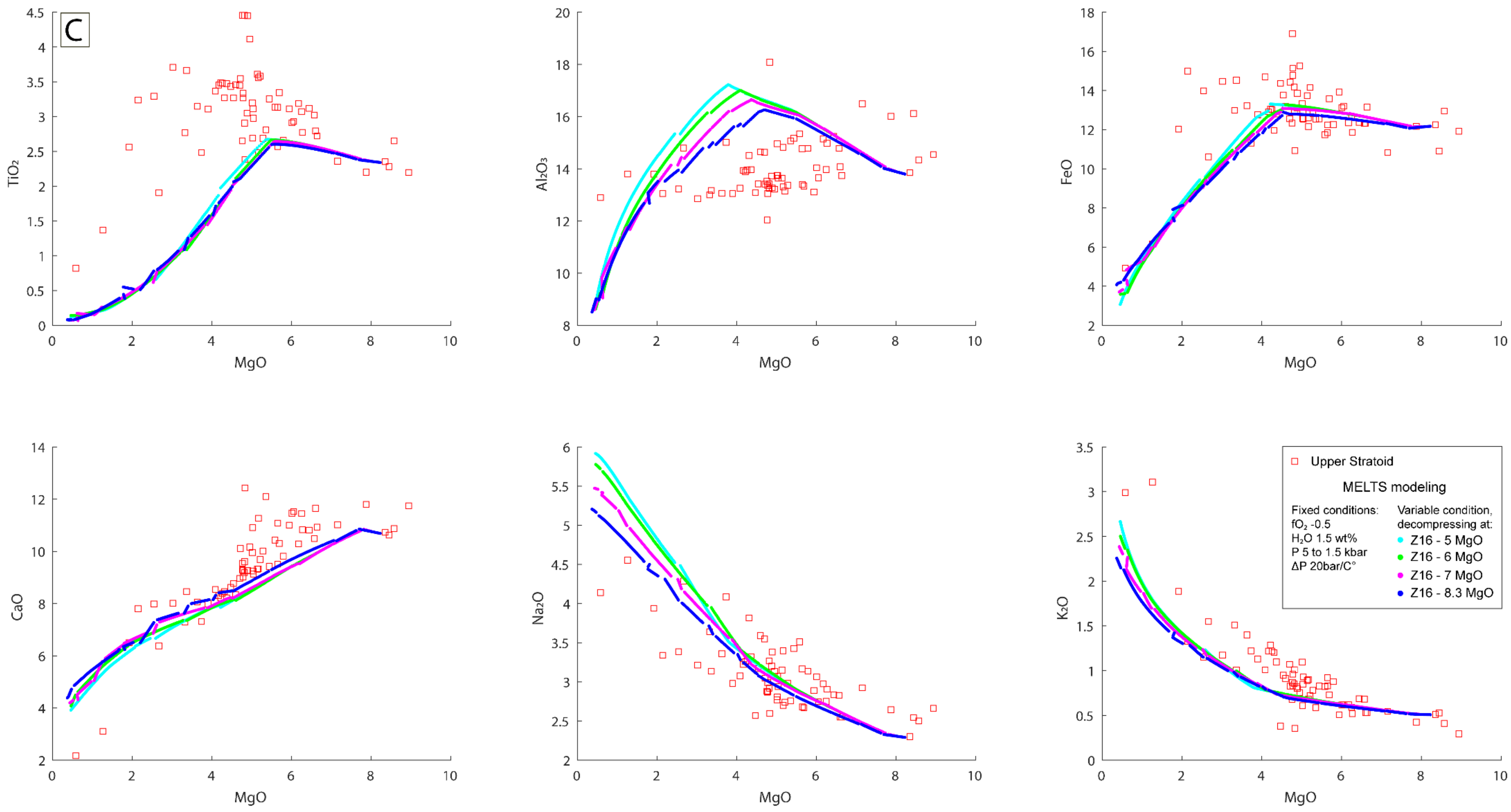

B
TiO₂
Al₂O₃
FeO
CaO
Na₂O
K₂O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO₂ -1
H₂O 1.5 wt%
P 5 to 1.5 kbar
ΔP 20bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO


B
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 1.5 wt%
P 5 to 1.5 kbar
ΔP 40bar/C°
Variable condition,
decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

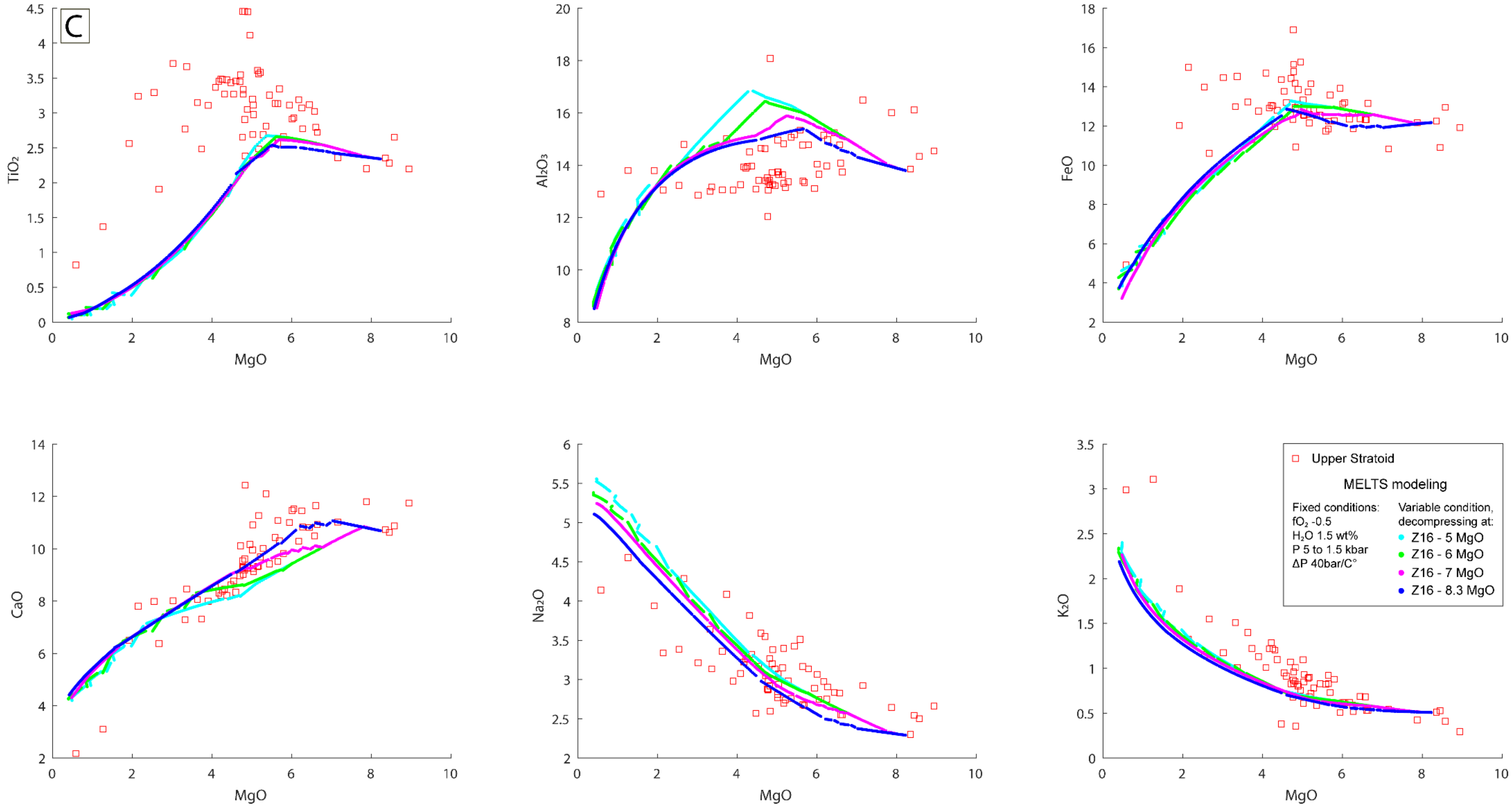


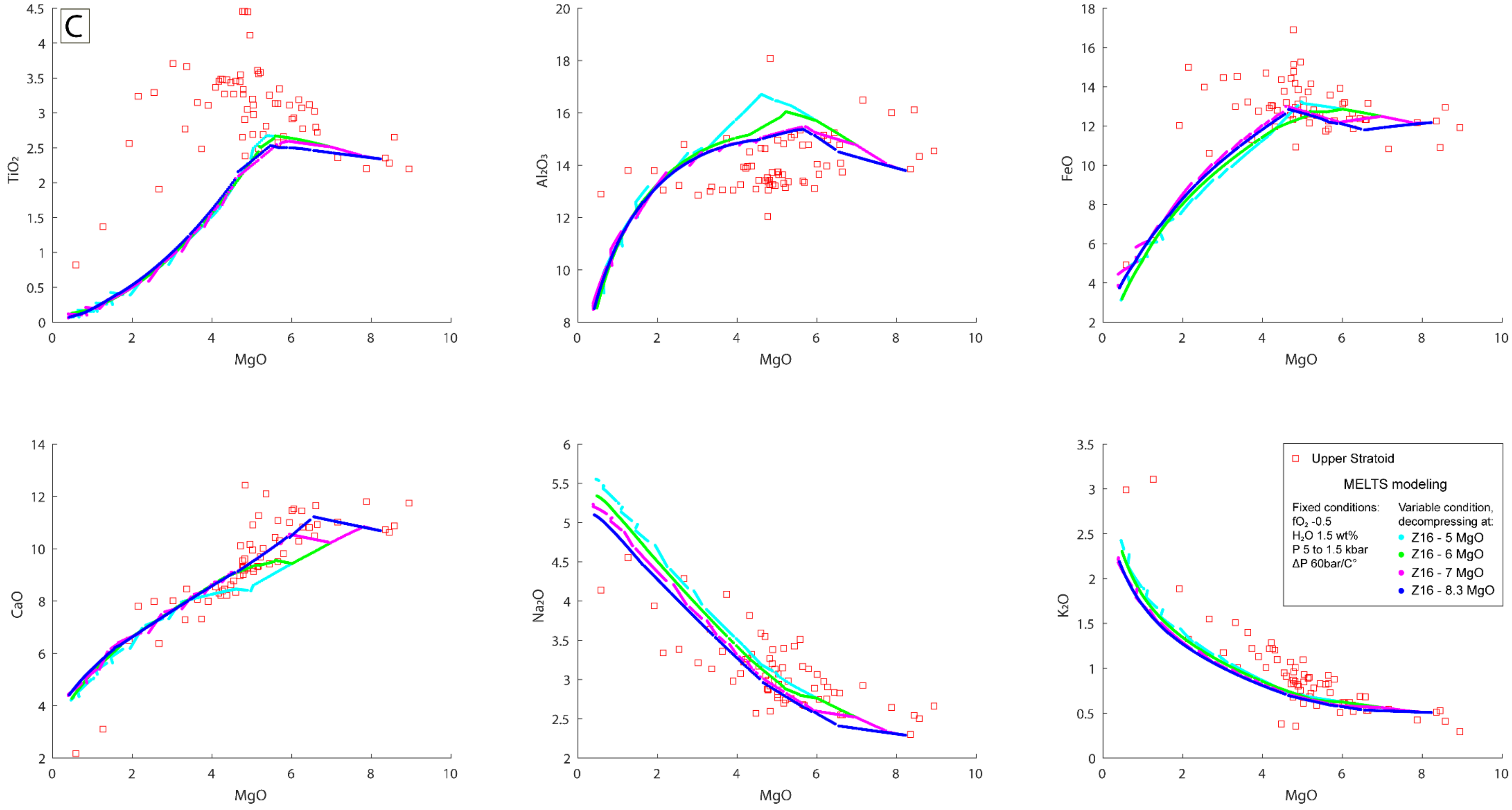
B
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 1.5 wt%
P 5 to 1.5 kbar
ΔP 60bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

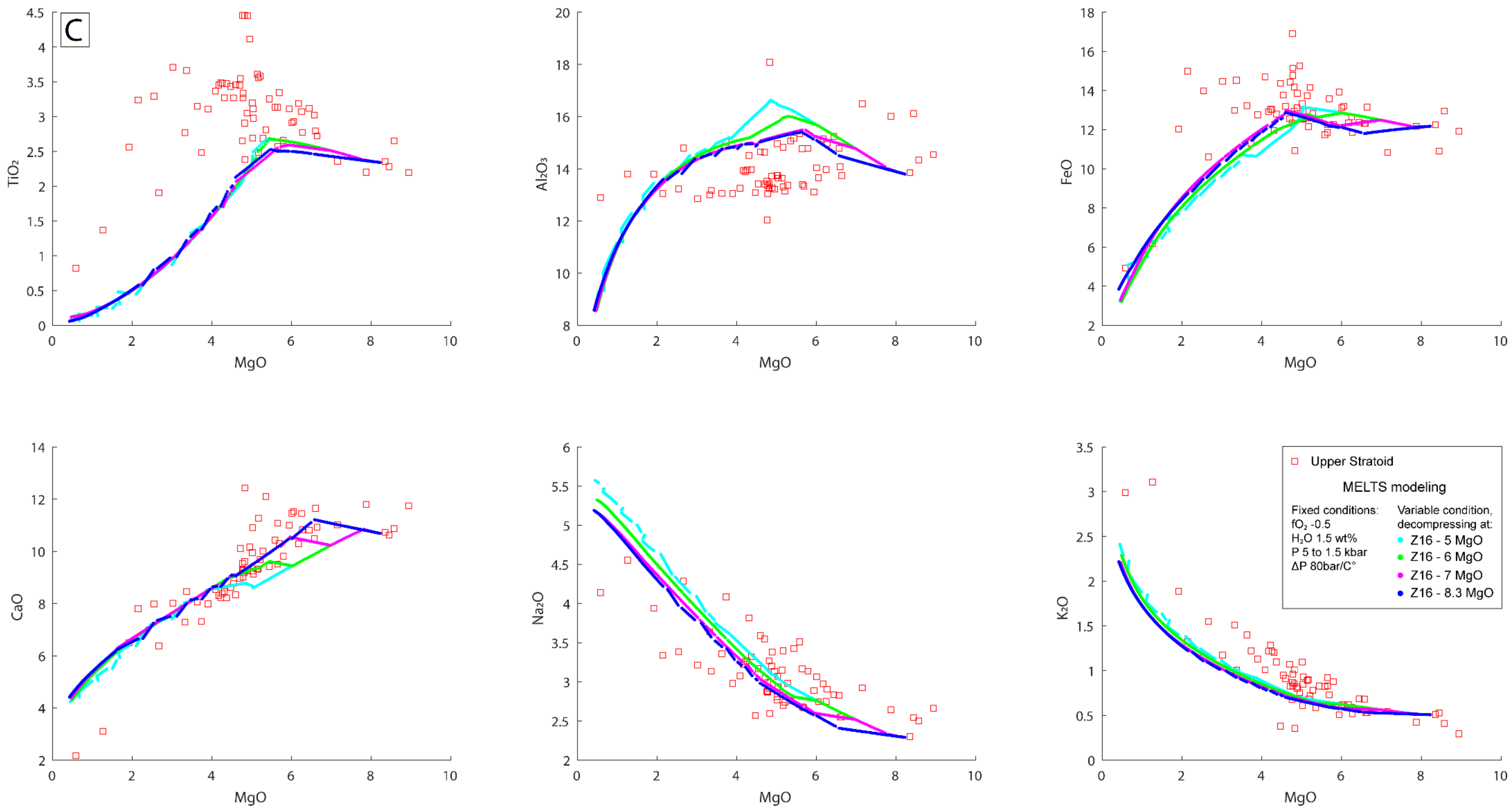

B
TiO₂
Al₂O₃
FeO
CaO
Na₂O
K₂O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO₂ -1
H₂O 1.5 wt%
P 5 to 1.5 kbar
ΔP 80bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

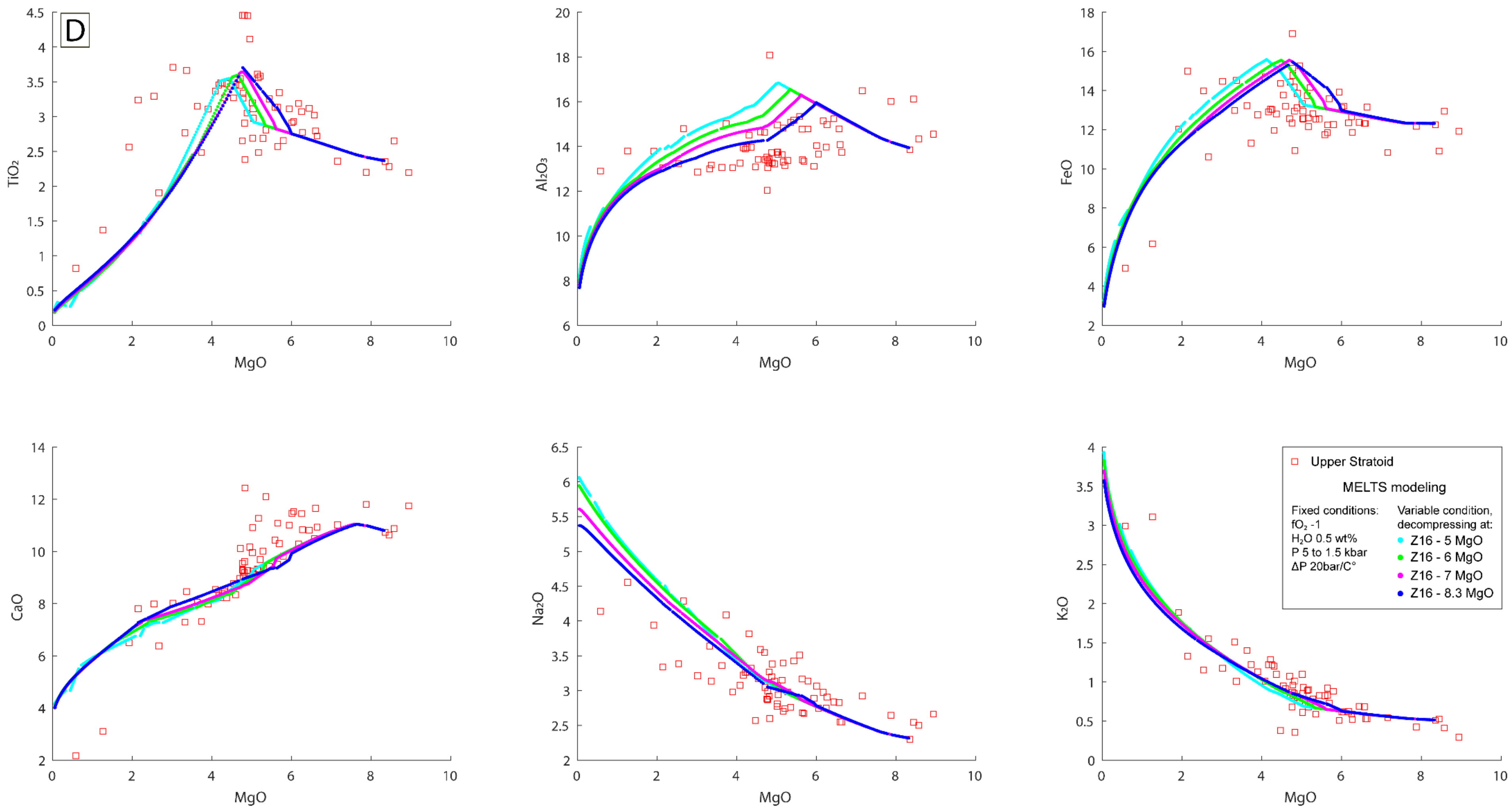


C
TiO₂
Al₂O₃
FeO
CaO
Na₂O
K₂O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO₂ -0.5
H₂O 1.5 wt%
P 5 to 1.5 kbar
ΔP 20bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

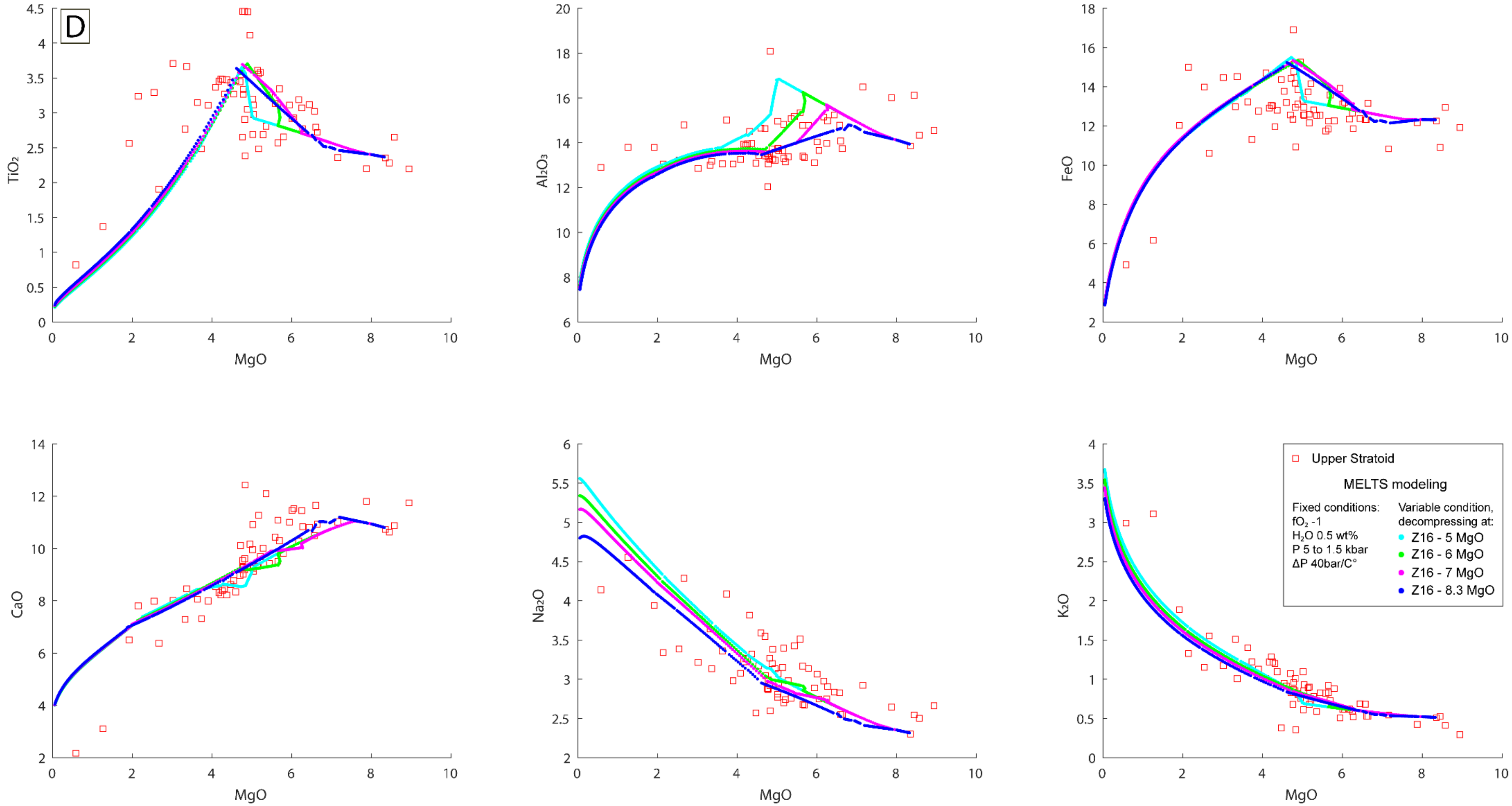

C
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -0.5
H2O 1.5 wt%
P 5 to 1.5 kbar
ΔP 40bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

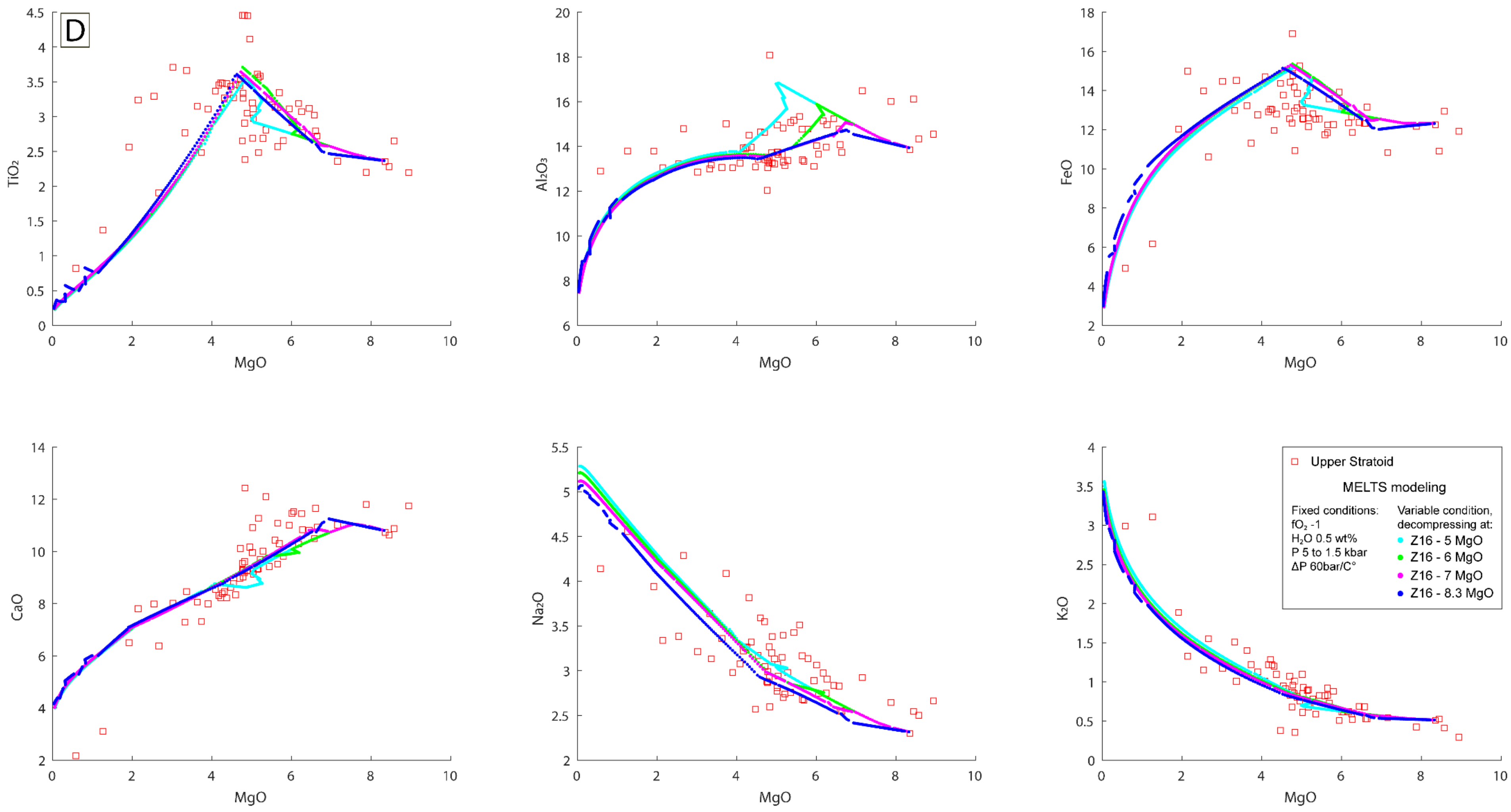

C
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -0.5
H2O 1.5 wt%
P 5 to 1.5 kbar
ΔP 60bar/C°
Variable condition,
decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO

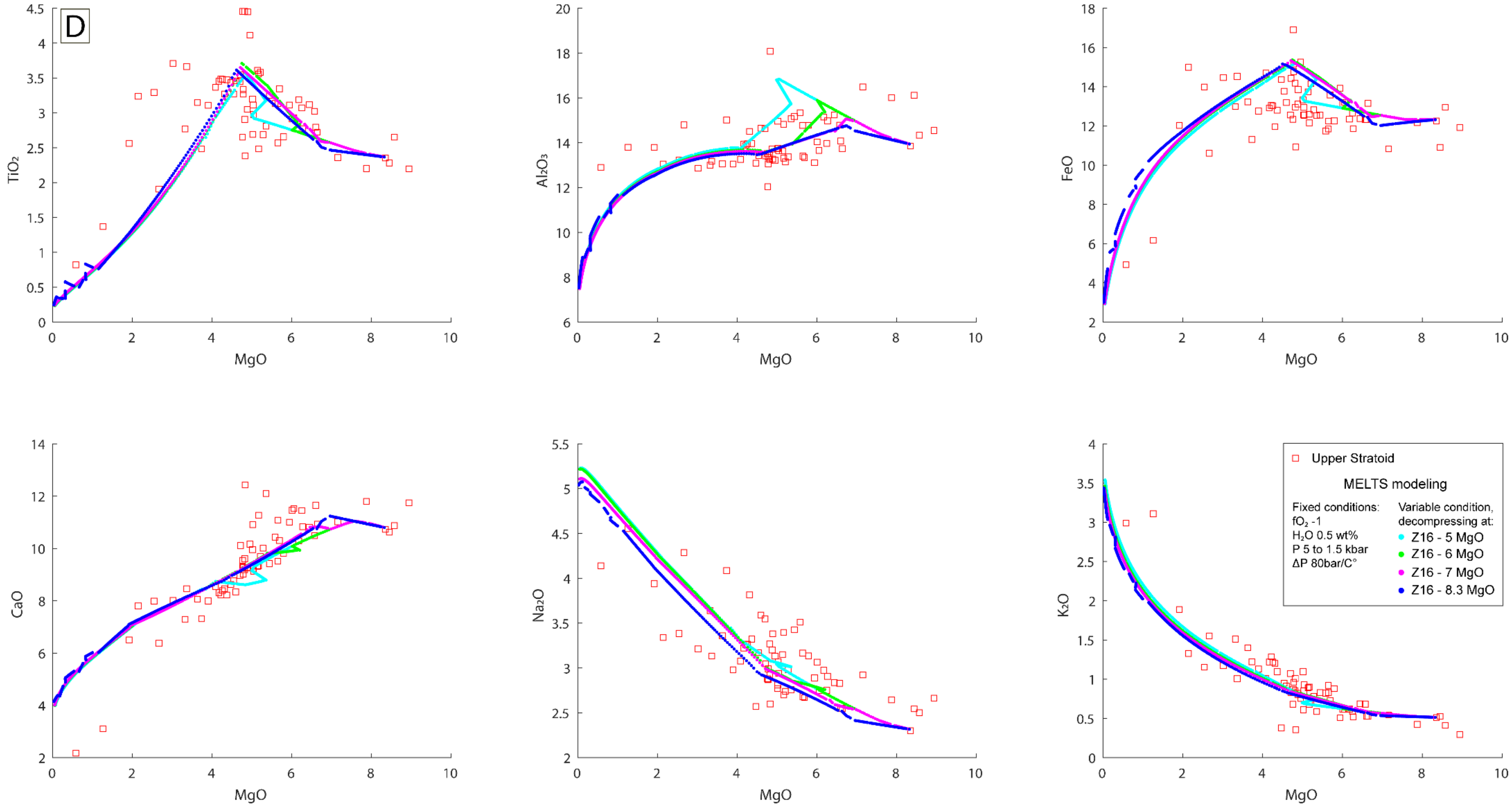

C
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -0.5
H2O 1.5 wt%
P 5 to 1.5 kbar
ΔP 80bar/C°
Variable condition,
decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO



D
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 20bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO


D
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 40bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO


D
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 60bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO


D
TiO2
Al2O3
FeO
CaO
Na2O
K2O
MgO
Upper Stratoid
MELTS modeling
Fixed conditions:
fO2 -1
H2O 0.5 wt%
P 5 to 1.5 kbar
ΔP 80bar/C°
Variable condition, decompressing at:
Z16 - 5 MgO
Z16 - 6 MgO
Z16 - 7 MgO
Z16 - 8.3 MgO