## Supplementary Material

The six figures in this supplement are concerned with the material in Figs 8 and 9 of the main paper. Fig. 1 shows the lithospheric thickness calculated from Schaeffer and Lebedev's (2013) velocity model, which produces lithospheric thicknesses slightly greater than those of Priestley et al. (2019), but is otherwise similar. Figs. 2-5 show the REE element concentrations of the individual samples used to calculate the average concentrations, and the fits of the melting models to a number of elements as well as to the REE. Only the average concentration ratios of the REE were used to determine the melt distributions. The last figure, 6, shows the fit of the melting model for the Hamadan volcanics (Allen et al. 2013, M$^{c}$Kenzie & Priestley 2016) to a variety of different elements, together with the geotherm for the same location, using Priestley et al.'s (2019) velocity model. Only temperature estimates from $V_{sv}$ above the horizontal red dashed line and to the right of the vertical red dashed line were used to determine the geotherm.

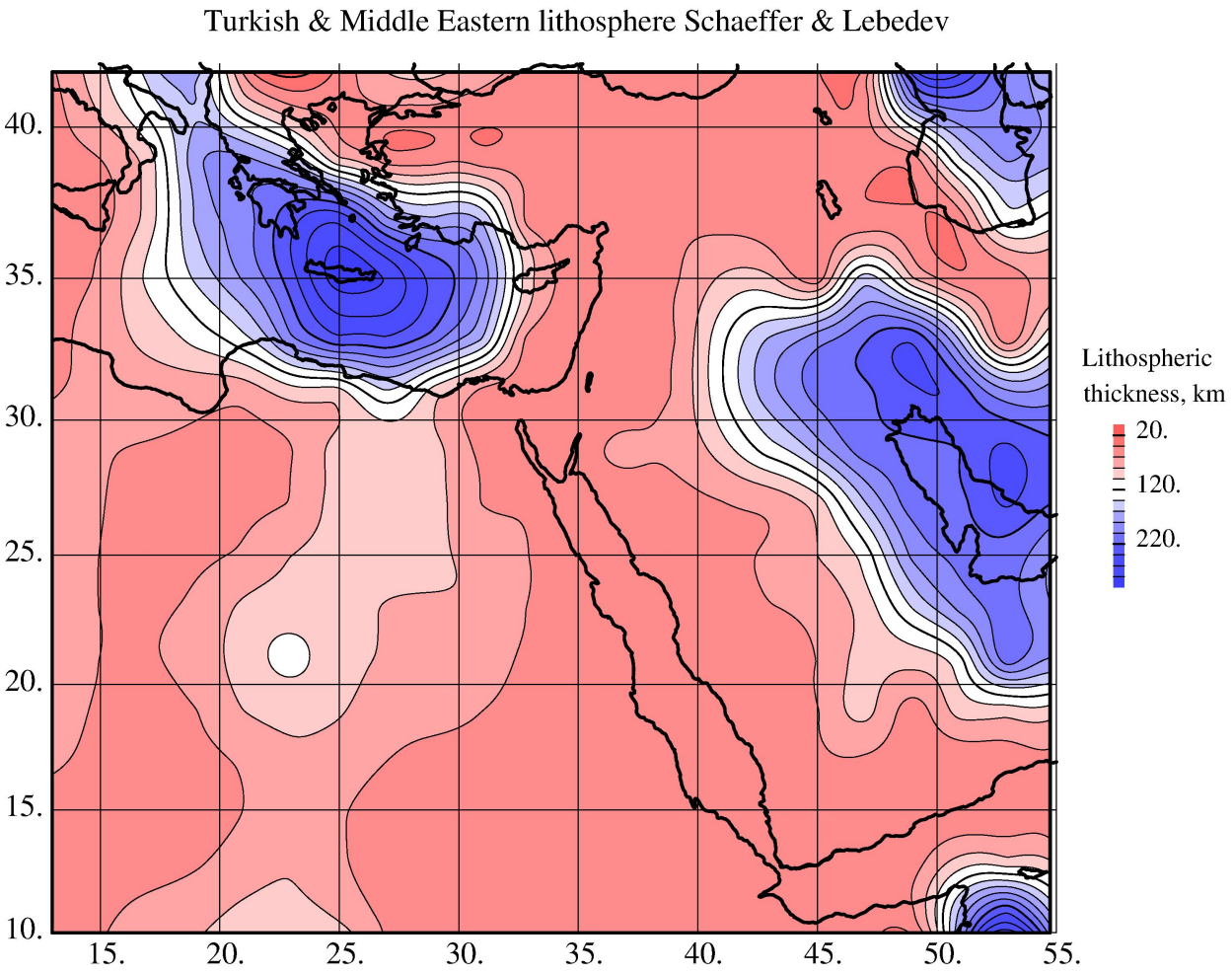


Figure 1:

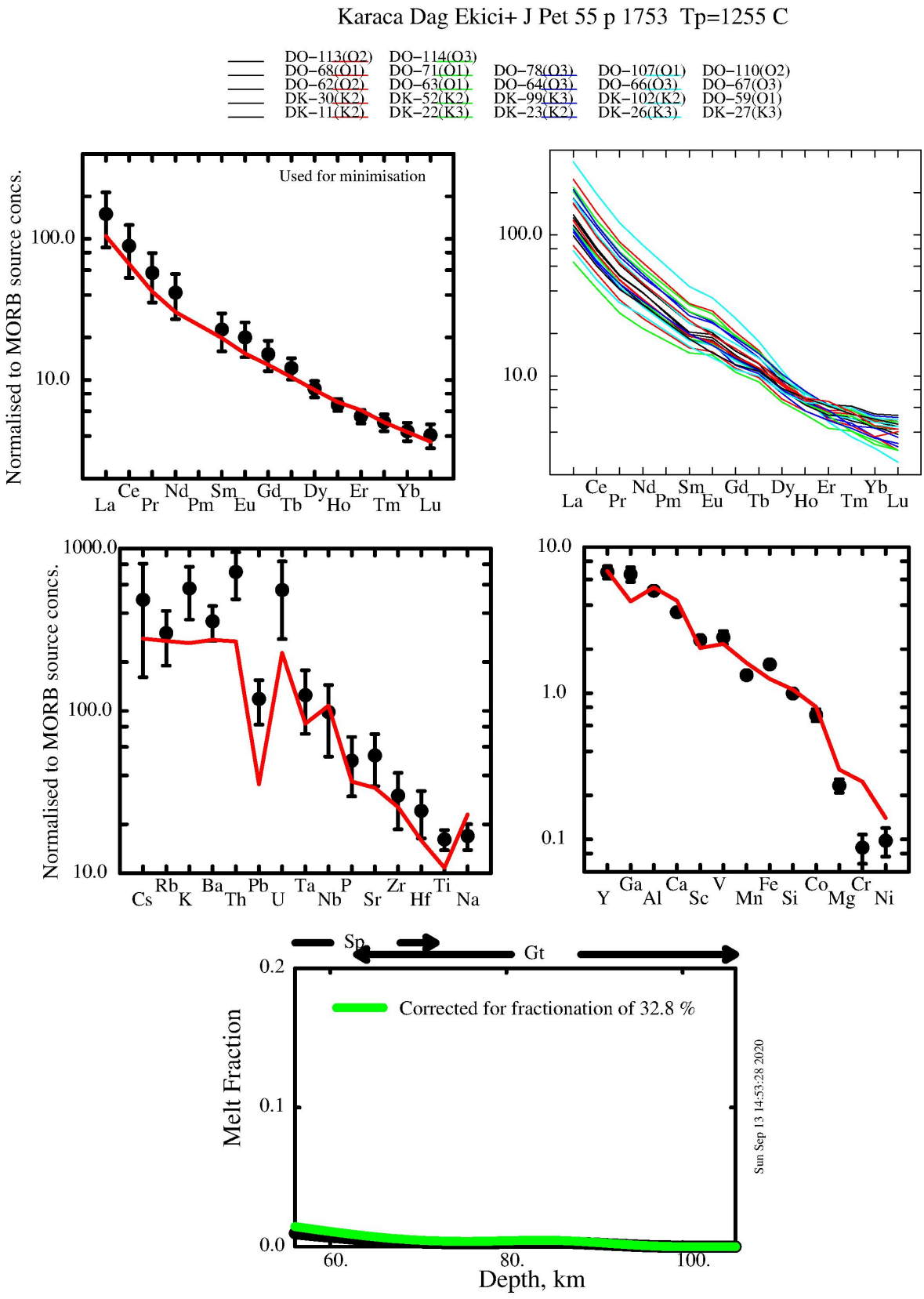
Karaca Dag Ekici+ J Pet 55 p 1753 Tp=1255 C
DO−113(O2) DO−114(O3)
DO−68(O1) DO−71(O1) DO−78(O3) DO−107(O1) DO−110(O2)
DO−62(O2) DO−63(O1) DO−64(O3) DO−66(O3) DO−67(O3)
DK−30(K2) DK−52(K2) DK−99(K3) DK−102(K2) DO−59(O1)
DK−11(K2) DK−22(K3) DK−23(K2) DK−26(K3) DK−27(K3)
Used for minimisation
Normalised to MORB source concs.
100.0
10.0
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
1000.0
Cs Rb K Ba Th Pb U Ta Nb P Sr Zr Hf Ti Na
1.0
0.1
Y Ga Al Ca Sc V Mn Fe Si Co Mg Cr Ni
Sp
Gt
Corrected for fractionation of 32.8 %
Melt Fraction
0.2
0.0
60.
80.
100.
Depth, km
Sun Sep 13 14:53:28 2020

Figure 2:

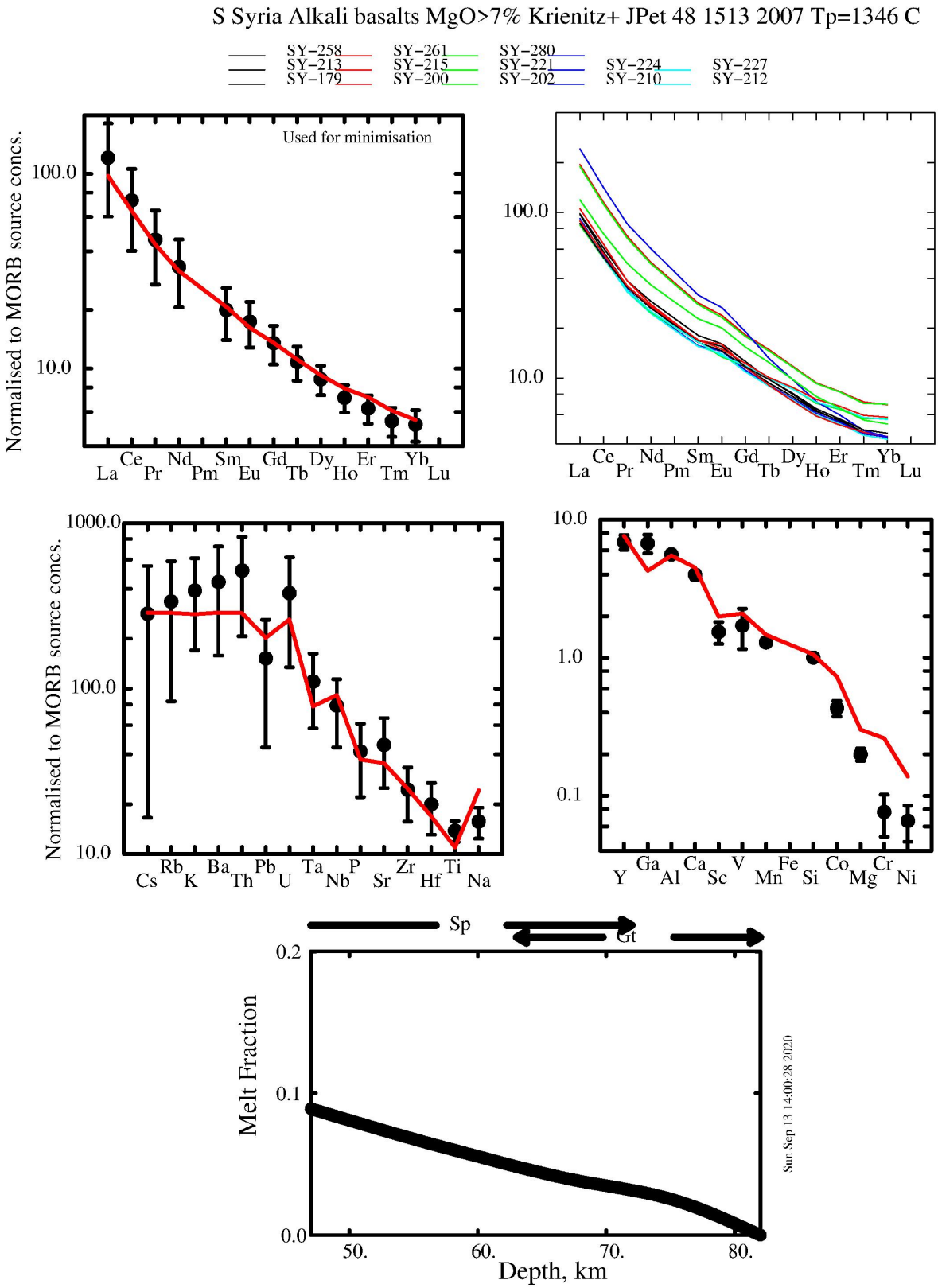
S Syria Alkali basalts MgO>7% Krienitz+ JPet 48 1513 2007 Tp=1346 C
SY-258
SY-213
SY-179
SY-261
SY-215
SY-200
SY-280
SY-221
SY-202
SY-224
SY-210
SY-227
SY-212
Used for minimisation
Normalised to MORB source concs.
100.0
10.0
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
1000.0
Cs Rb K Ba Th Pb U Ta Nb P Sr Zr Hf Ti Na
1.0
0.1
Y Ga Al Ca Sc V Mn Fe Si Co Mg Cr Ni
Sp
Gt
Melt Fraction
0.2
0.0
50.
60.
70.
80.
Depth, km
Sun Sep 13 14:00:28 2020

Figure 3:

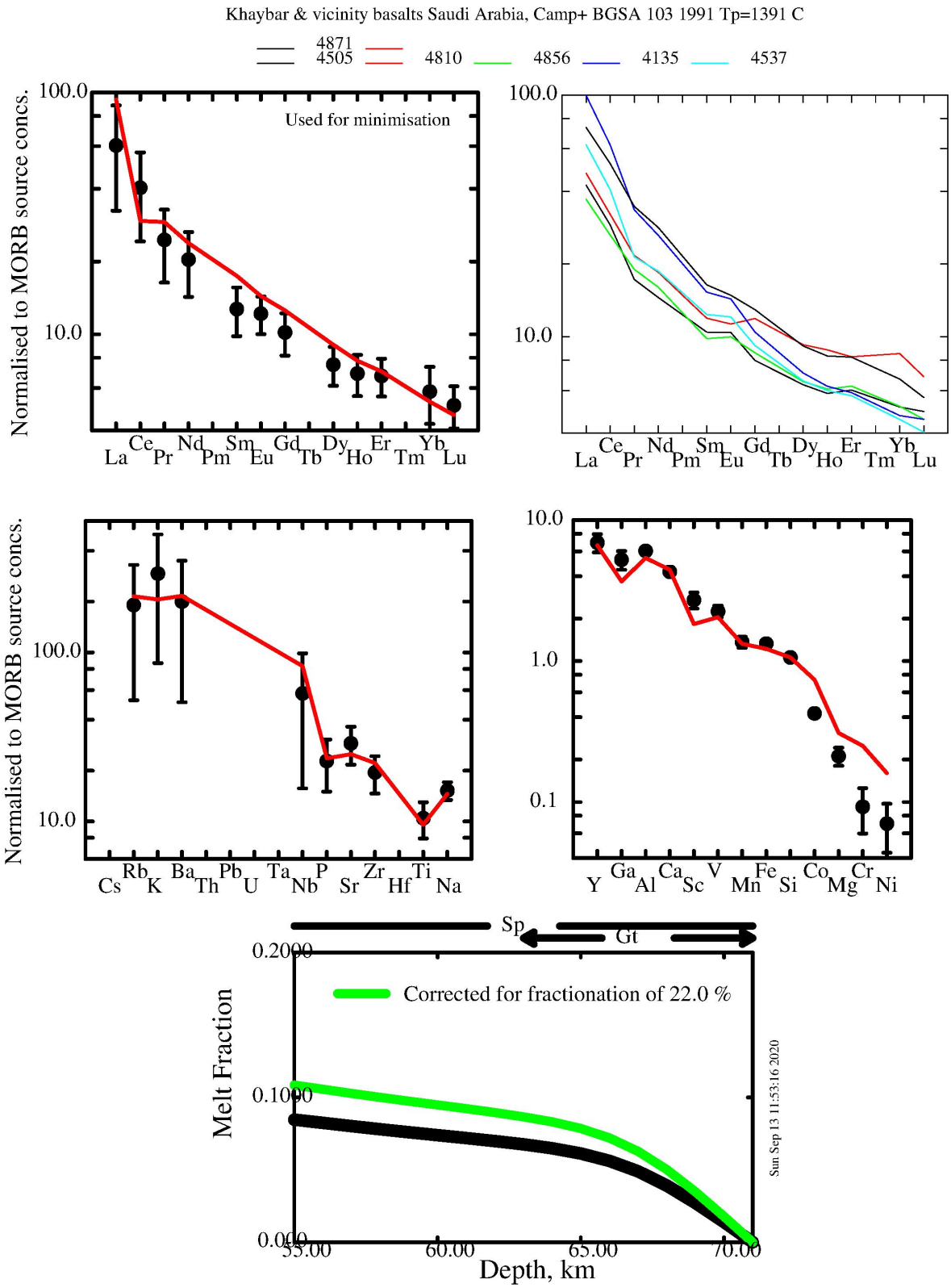
Khaybar & vicinity basalts Saudi Arabia, Camp+ BGSA 103 1991 Tp=1391 C
4871
4505
4810
4856
4135
4537
Normalised to MORB source concs.
100.0
10.0
Used for minimisation
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Cs Rb K Ba Th Pb U Ta Nb P Sr Zr Hf Ti Na
1.0
0.1
Y Ga Al Ca Sc V Mn Fe Si Co Mg Cr Ni
Sp
Gt
Corrected for fractionation of 22.0 %
Melt Fraction
0.2000
0.1000
0.000
55.00
60.00
65.00
70.00
Depth, km
Sun Sep 13 11:53:16 2020

Figure 4:

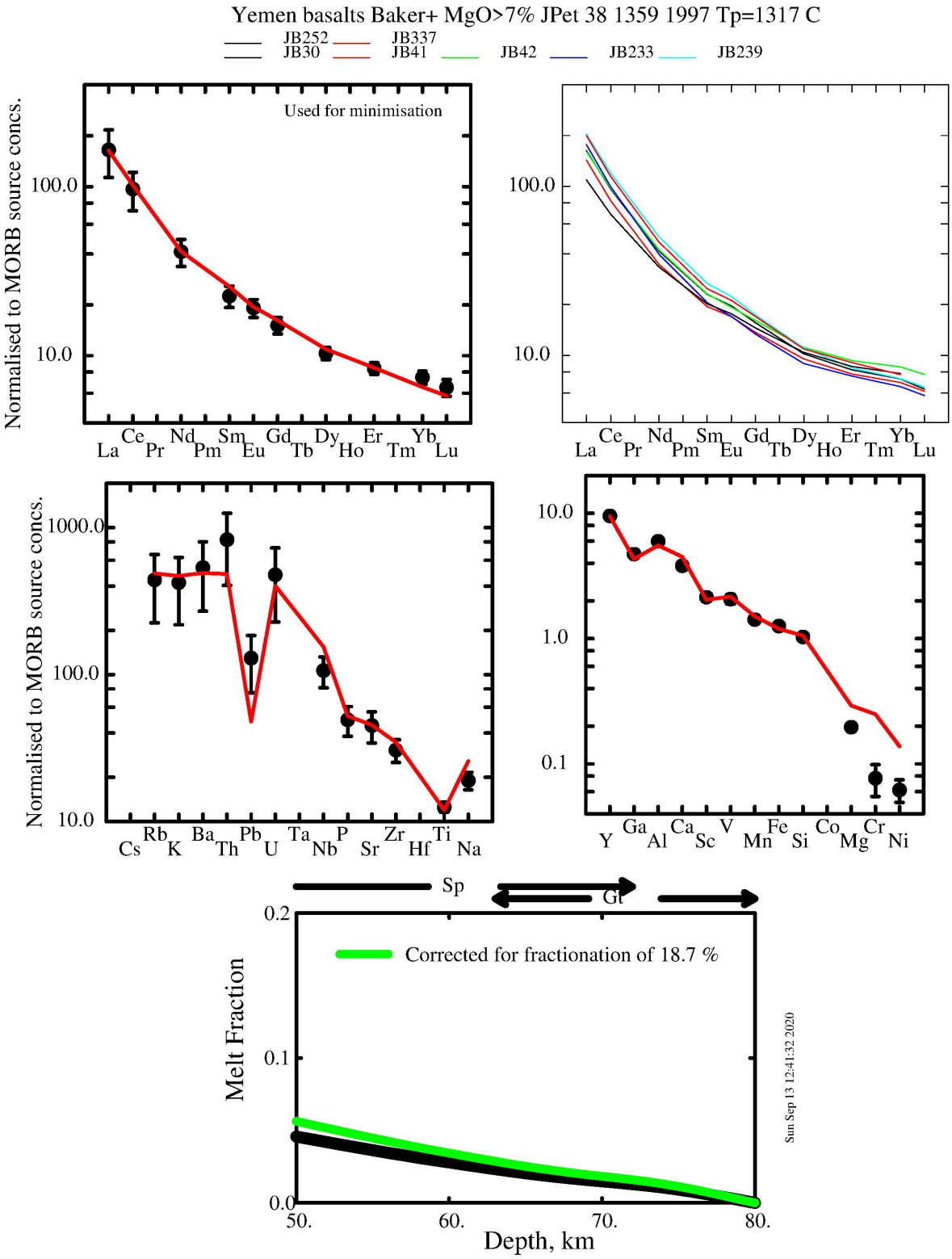
Yemen basalts Baker+ MgO>7% JPet 38 1359 1997 Tp=1317 C
JB252
JB30
JB337
JB41
JB42
JB233
JB239
Used for minimisation
Normalised to MORB source concs.
100.0
10.0
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
1000.0
Cs Rb K Ba Th Pb U Ta Nb P Sr Zr Hf Ti Na
1.0
0.1
Y Ga Al Ca Sc V Mn Fe Si Co Mg Cr Ni
Sp
Gt
Corrected for fractionation of 18.7 %
Melt Fraction
0.2
0.0
50.
60.
70.
80.
Depth, km
Sun Sep 13 12:41:32 2020

Figure 5:

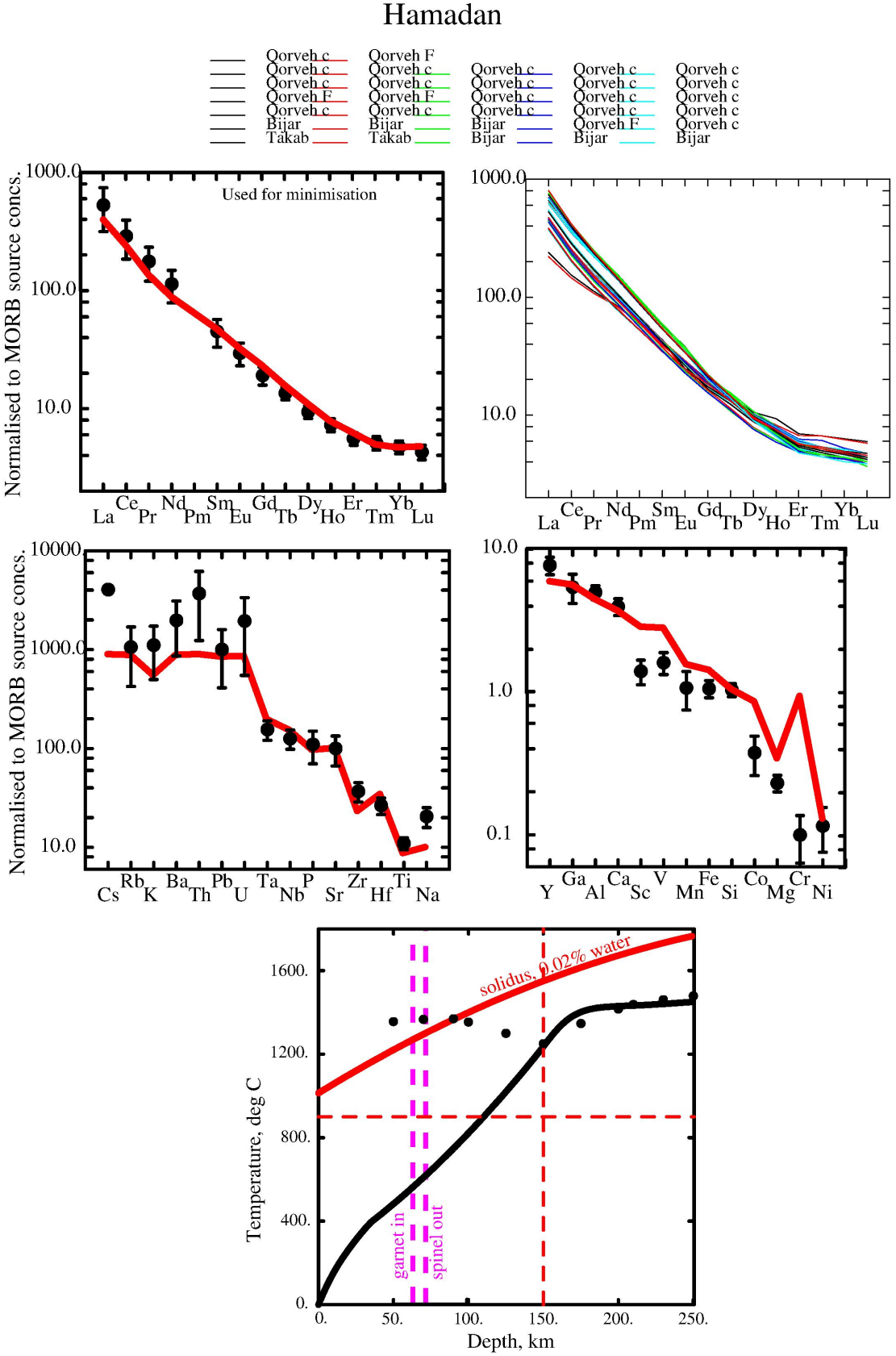
Hamadan
Qorveh c
Qorveh F
Bijar
Takab
Used for minimisation
Normalised to MORB source concs.
1000.0
100.0
10.0
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
10000
1000.0
100.0
10.0
Cs Rb K Ba Th Pb U Ta Nb P Sr Zr Hf Ti Na
1.0
0.1
Y Ga Al Ca Sc V Mn Fe Si Co Mg Cr Ni
solidus, 0.02% water
garnet in
spinel out
Temperature, deg C
1600.
1200.
800.
400.
0.
0. 50. 100. 150. 200. 250.
Depth, km

Figure 6: