Comparison of fluid inclusion studies in cordierite-andalusite-rich leuco-granite dykes and tourmaline-bearing aplite-pegmatite dykes Elba (Italy)

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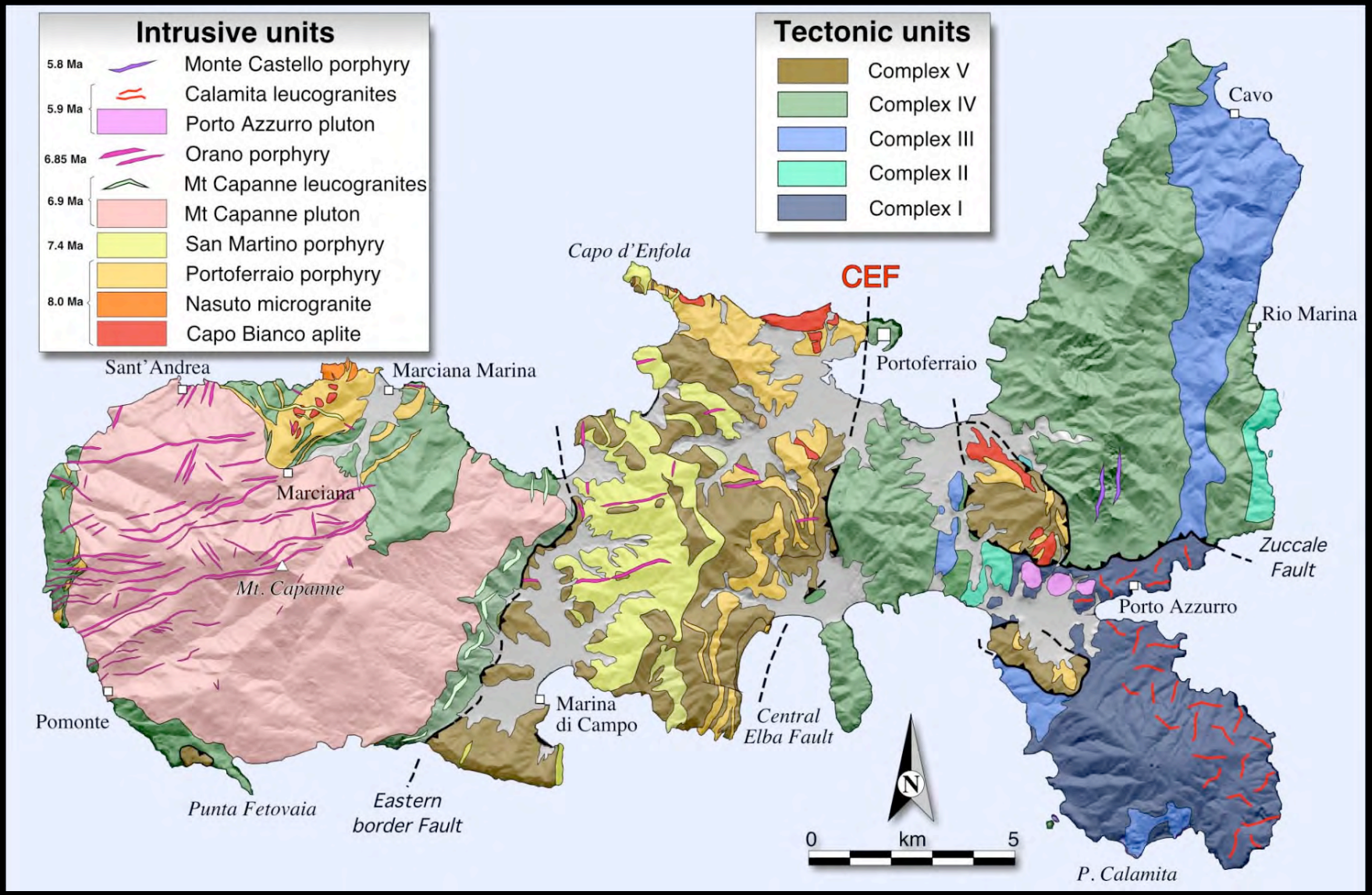
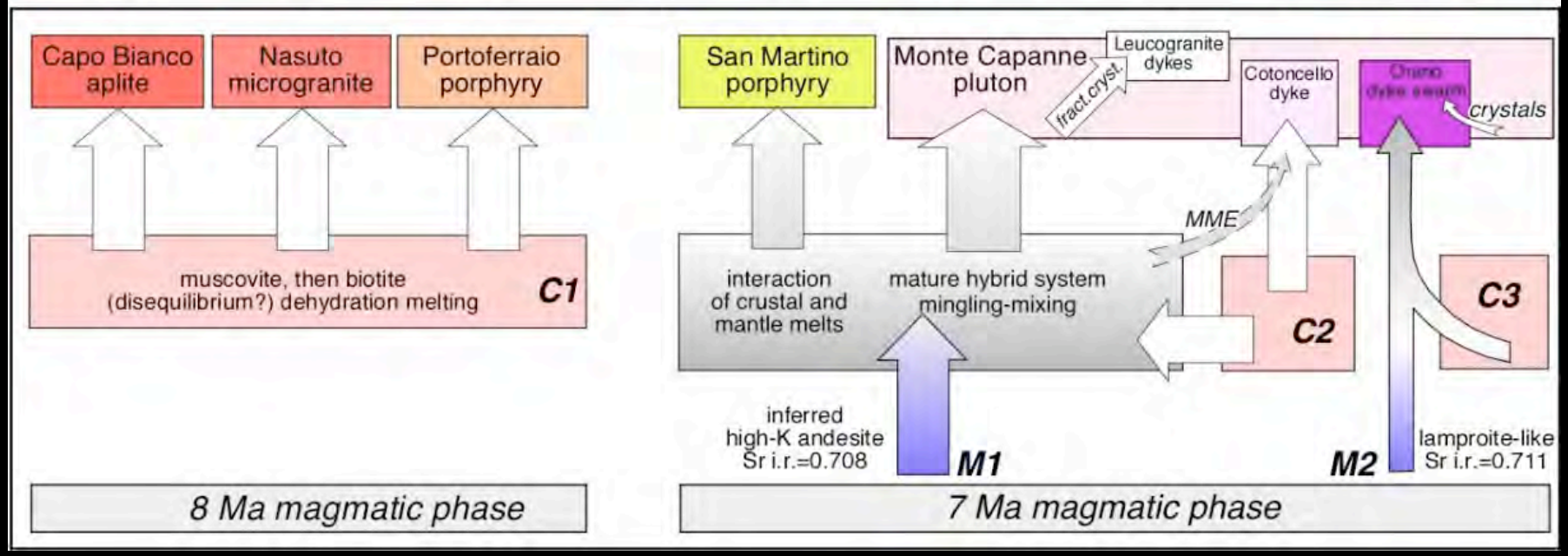
Elba island



from Rocchi et al. (2008) LASI III Conference, Field Guidebook

Magmatism Elba Island

0.4	low	28	volume (km^3)	24	~ 200	low	very low	low
no	no	no	mafic enclaves	common	common, variable %	no	small	common
1.42	1.29	1.18	average ASI	1.22	1.11	1.15	1.16	0.94 (min)
0.7115-0.7133	0.7146	0.7144	$^{87}Sr/^{86}Sr(t)$	0.7162	0.7145 - 0.7147	0.7145	0.7228	0.7115 (min)
-9.6	-9.9	-10.0	$\varepsilon_{Nd}(t)$	-8.8	-8.1 - -8.8	-8.6	-9.7	-7.0 (max)



from Rocchi et al. (2008) LASI III Conference, Field Guidebook after Dini et al. (2002)

Monte Capanne Pluton

monzogranite - granodiorite

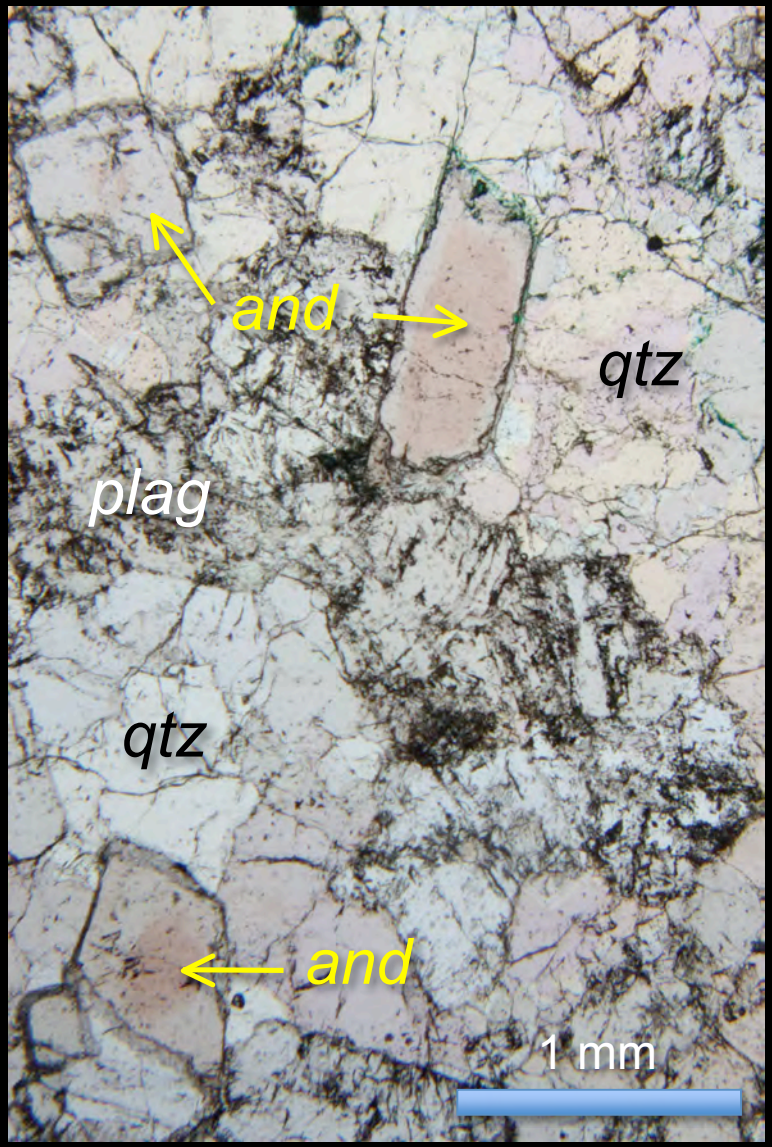
pegmatite-aplite-leucogranite dykes
in granite

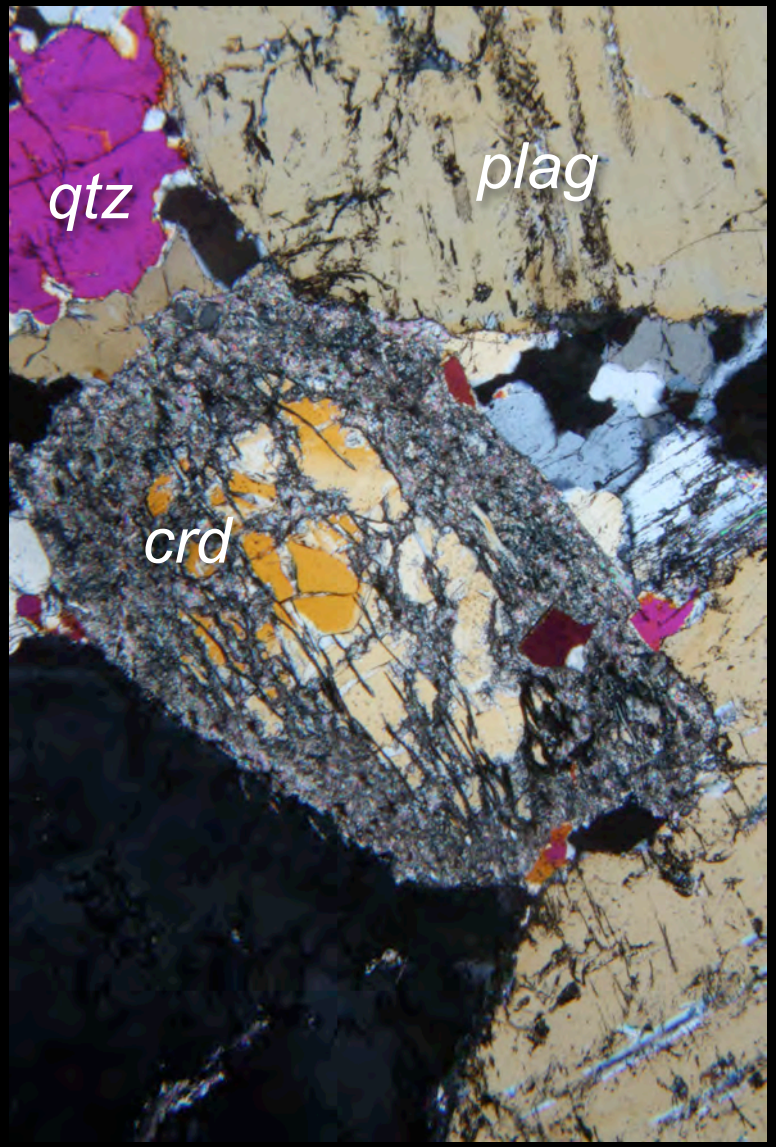
leucogranite dykes
in metasediments

textural and mineralogical zoning of pegmatite-aplite dykes

andalusite and cordierite

leucogranite dyke



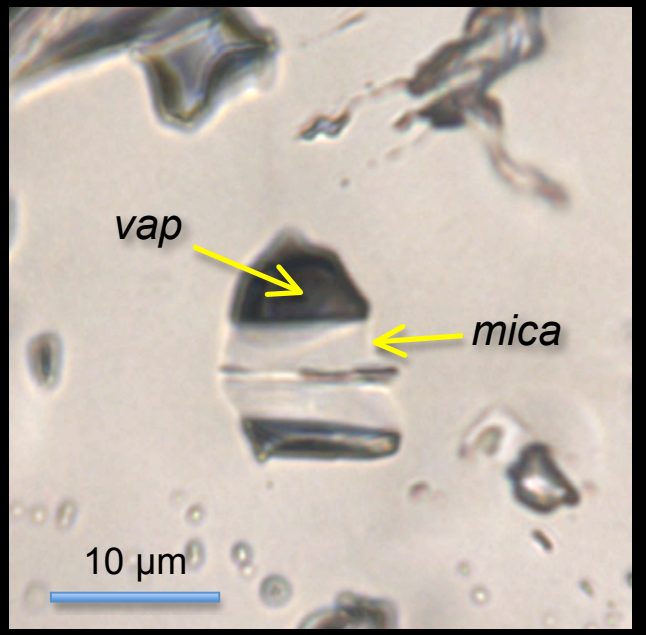


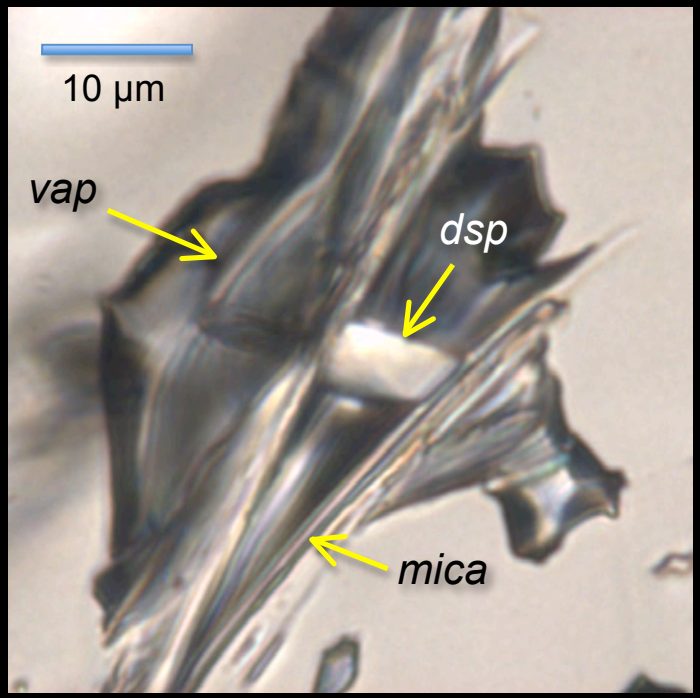
leucogranite dyke

Fluid Inclusions in Andalusite

Raman: $x(CO_2)$ = 0.941 – 0.983
$x(N_2)$ = 0.013 – 0.034
$x(CH_4)$ = 0.001 – 0.026
$x(H_2)$ = 0.003 – 0.017

} vapour

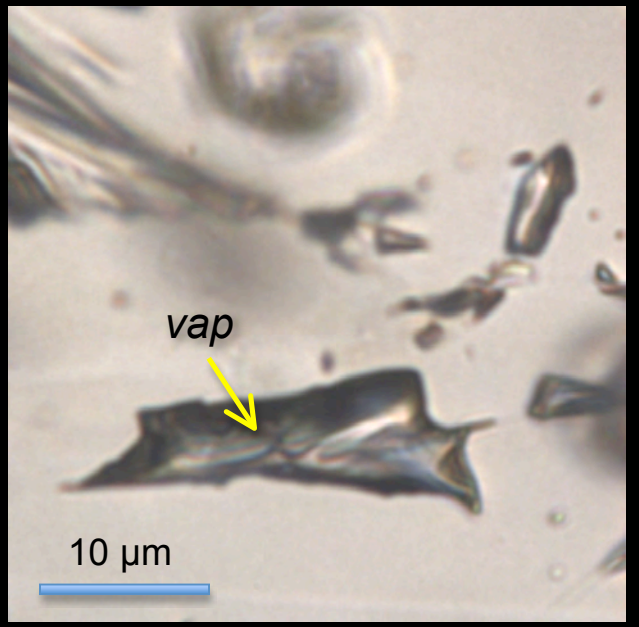




absence of H_2O
diaspore
quartz

"step daughters"

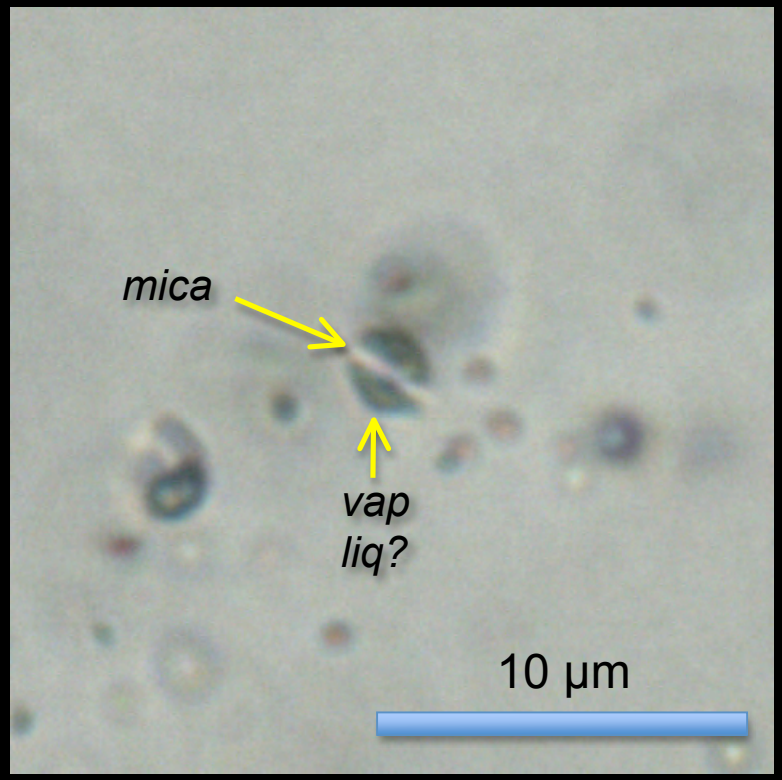
post-entrapment
fluid-host interaction



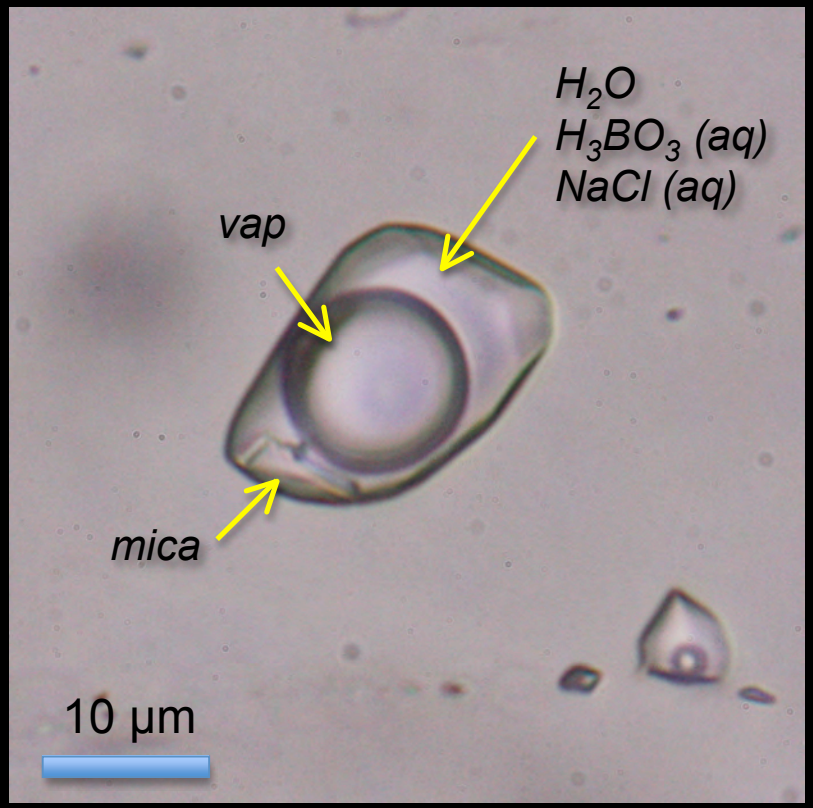
First generation fluid inclusions in Quartz

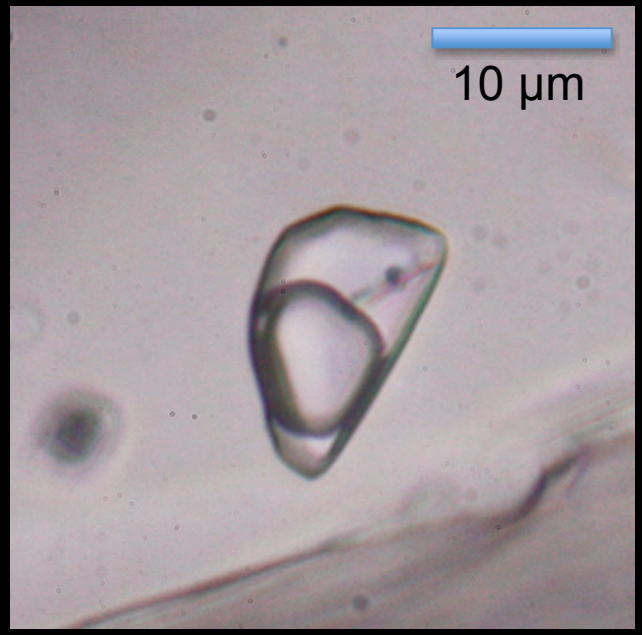
First generation fluid inclusions in Quartz

Raman: mixture H_2O (liq) + H_2 (vap)



Second generation fluid inclusions in Quartz





microthermometry T_m(ice) and T_m(cla)
volume fraction φ^{vap}

software "*ICE*" package *CLATHRATES* (Bakker, 1997)

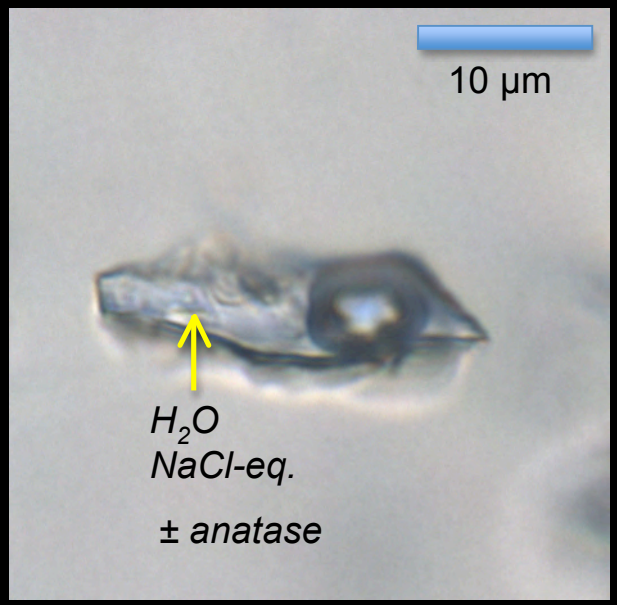
Raman vapour: $x(CO_2)$ = 0.207 – 0.910
$x(CH_4)$ = 0.047 – 0.638
$x(H_2)$ = 0.006 – 0.125
$x(N_2)$ = 0.008 – 0.030
± H_2S, C_2H_6

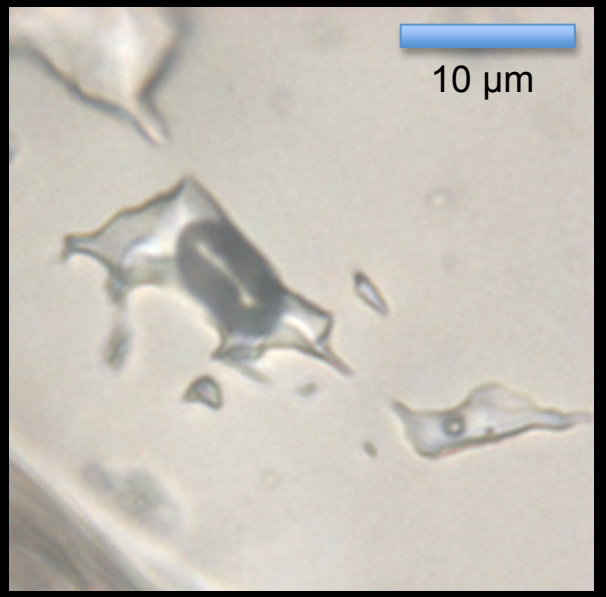
bulk V_m-x properties:

$x(H_2O)$ = 0.911 – 0.958
$x(CO_2)$ = 0.029 – 0.068
$x(CH_4)$ = 0.015 - 0.033
$x(N_2+H_2)$ = 0.001 – 0.003
x(NaCl) = 0.009 – 0.022
V_m = 30.43 – 31.70 $cm^3 \cdot mol^{-1}$

Third generation fluid inclusions in Quartz

heterogeneous distribution of fluid after necking processes





Raman vapour: $x(CH_4)$ = 0.115 – 0.588

$x(H_2)$ = 0.412 – 0.885

low density

microthermometry T_m(ice) ≅ T_m(cla)

volume fraction φ^{vap}

Q_1 clathrate dissolution

software "*ICE*" package *CLATHRATES*

bulk V_m-x properties

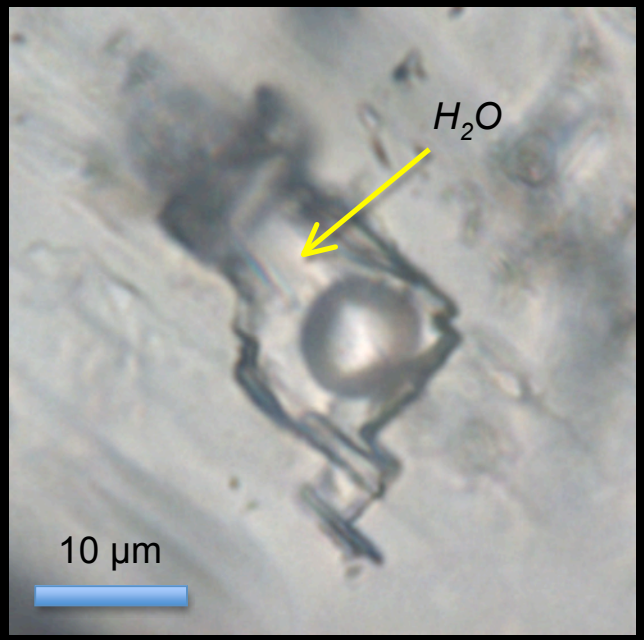
$x(H_2O)$ = 0.990 – 0.996

$x(CH_4+H_2)$ = 0.004 – 0.009

x(NaCl-eq.) = 0.000 – 0.004

V_m = 19.67 – 26.67 $cm^3 \cdot mol^{-1}$

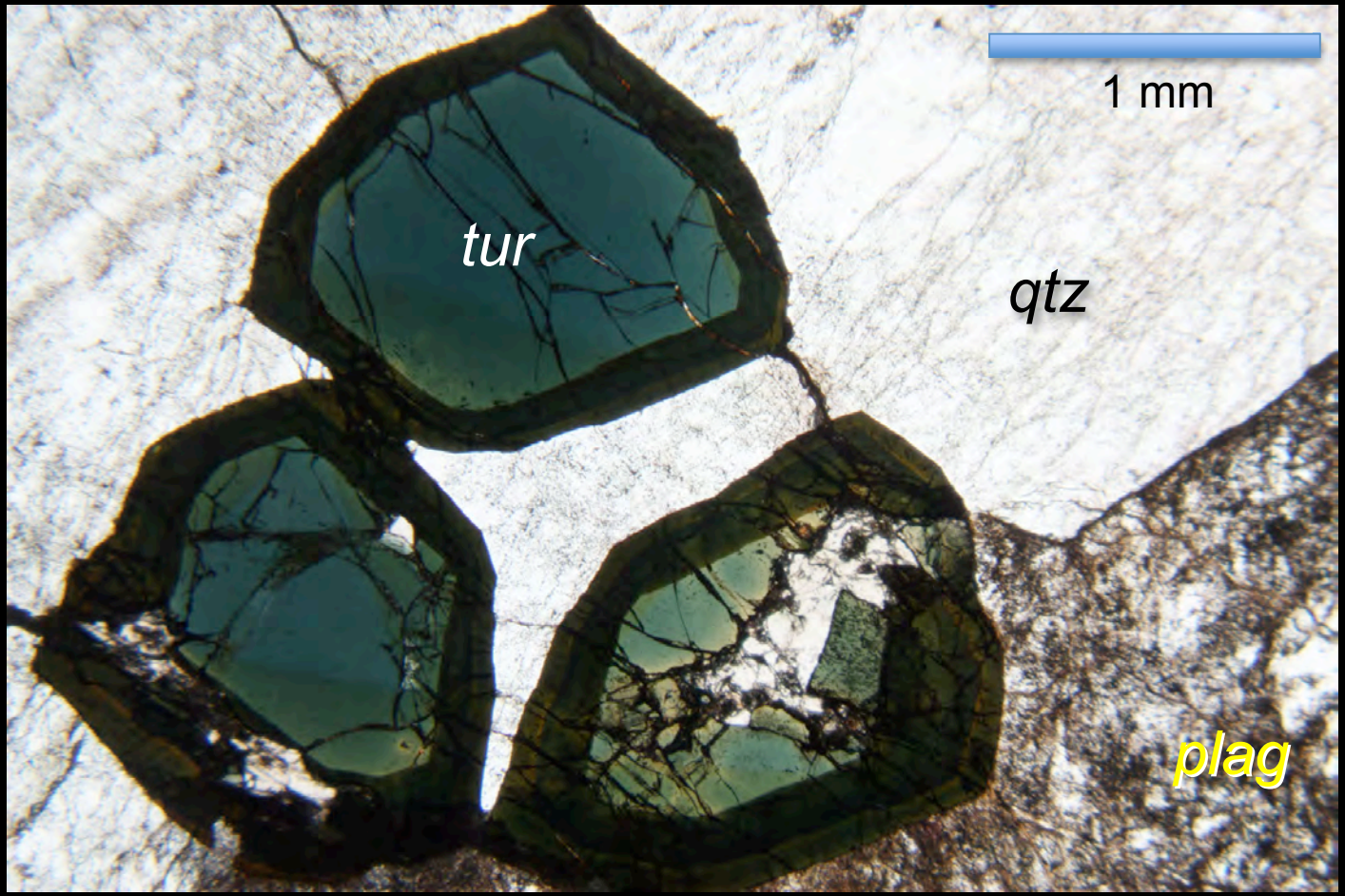
Fluid Inclusions in Plagioclase



Raman vapour: CH_4 and H_2

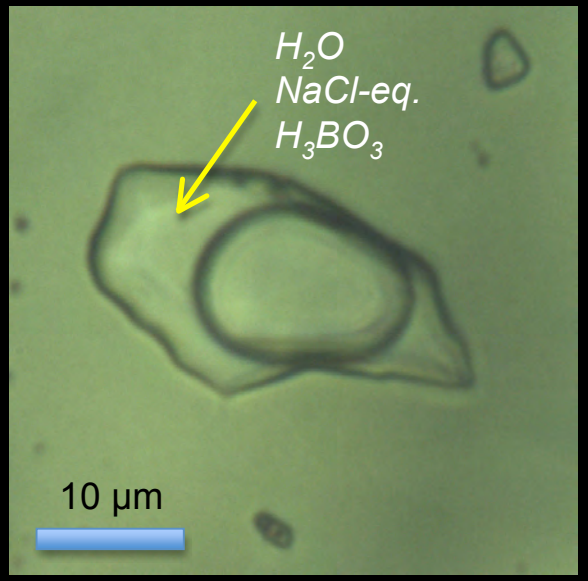
high fluorescence

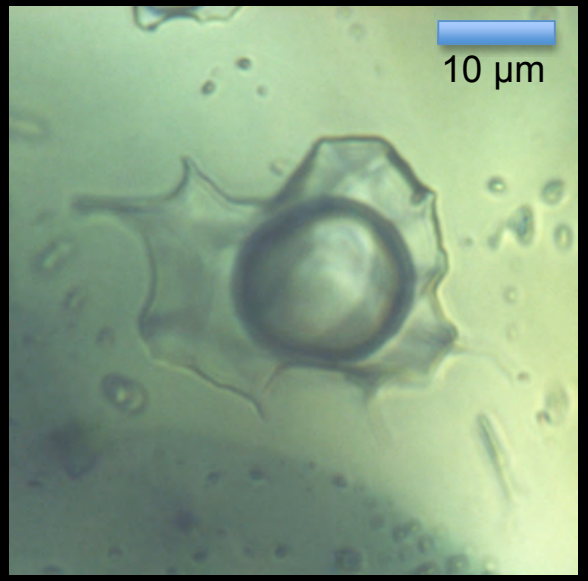
pegmatite-aplite dyke

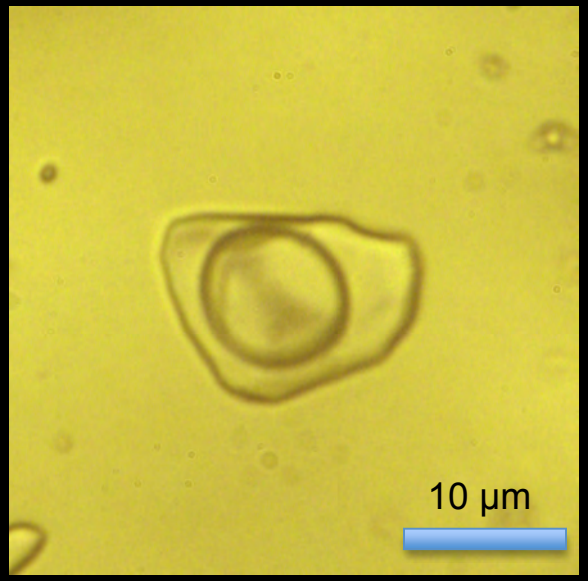


pegmatite-aplite dyke

Fluid Inclusions in Tourmaline







Raman vapour: $x(CO_2)$ = 0.125 – 0.997

$x(CH_4)$ = 0.003 – 0.672

± H_2S (< 2%), N_2 (< 20%), H_2(< 3%)

low density

Raman included solids: sassolite
± arsenolite
± arsenic

microthermometry T_m(ice) ≅ T_m(cla)
volume fraction φ^{vap}

bulk V_m-x properties

$x(H_2O)$ = 0.9463

$x(CO_2)$ = 0.0159 – 0.0174

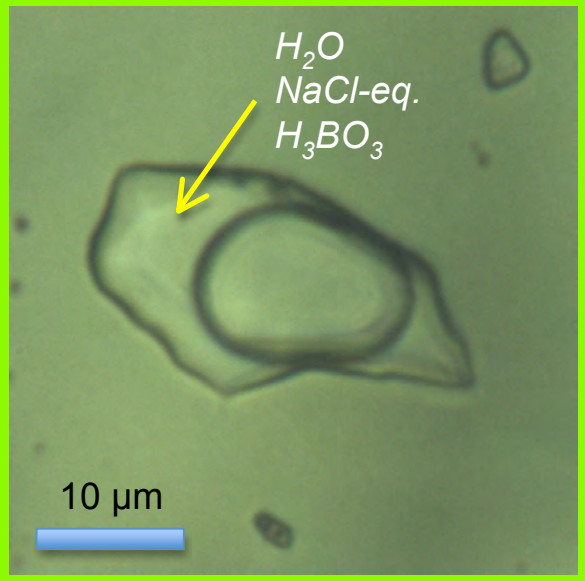
$x(CH_4)$ = 0.0001 – 0.0004

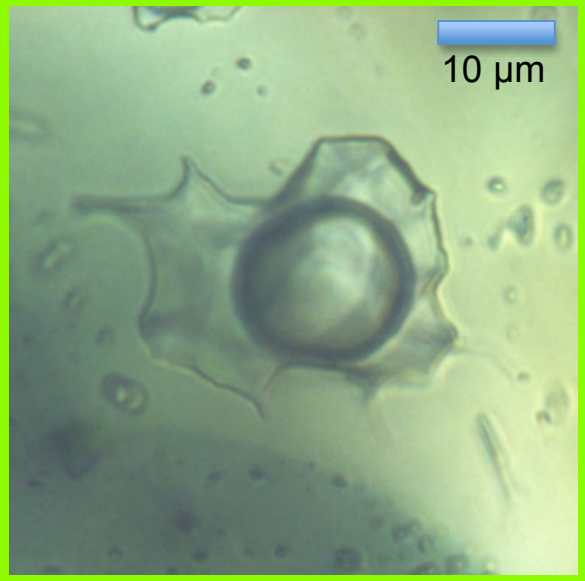
x(NaCl-eq.) = 0.0232 – 0.0244

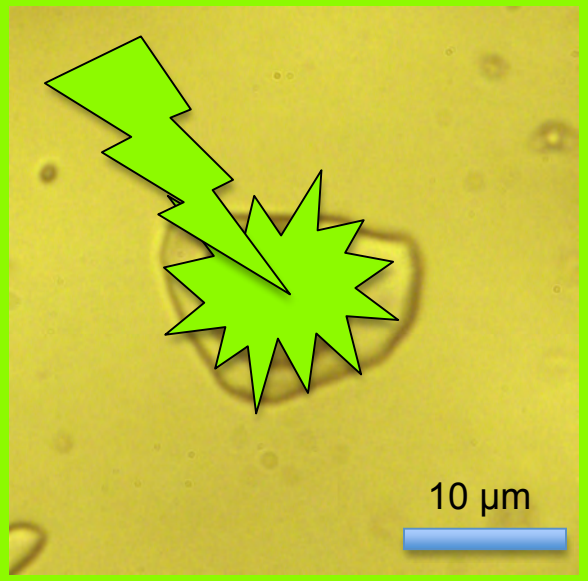
$x(H_3BO_3)$ = 0.0095 – 0.0099

V_m = 29.06 – 31.03 $cm^3 \cdot mol^{-1}$

Fluid Inclusions in Tourmaline







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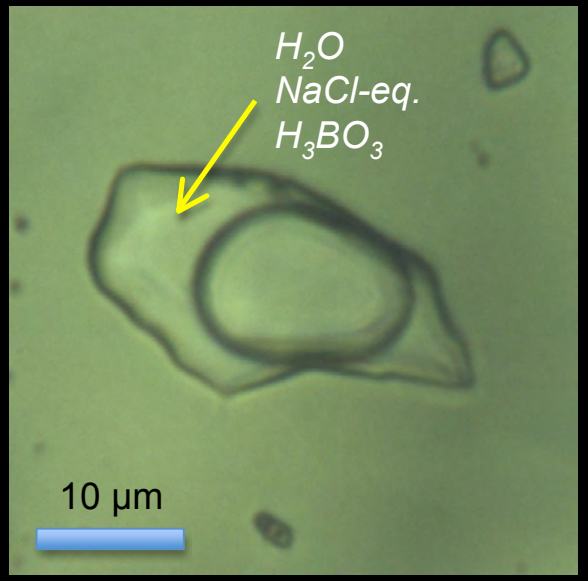

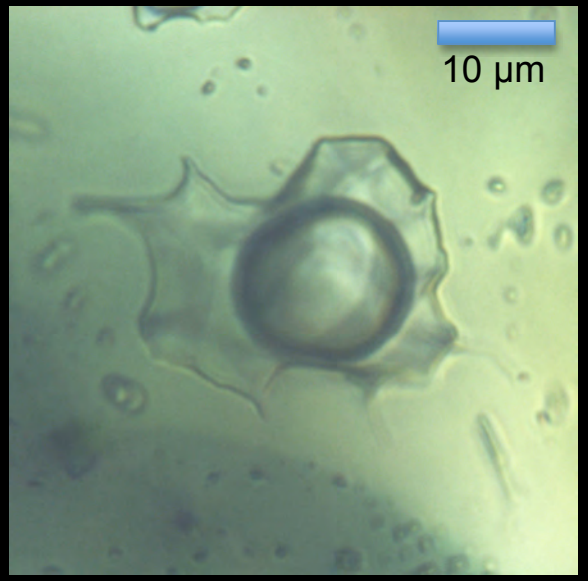

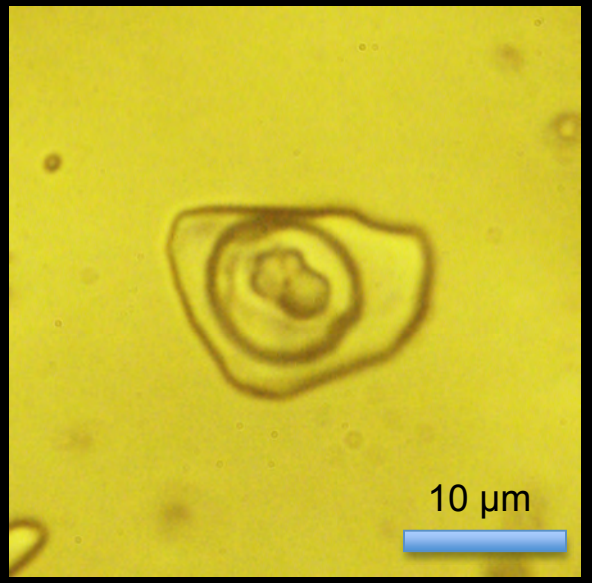

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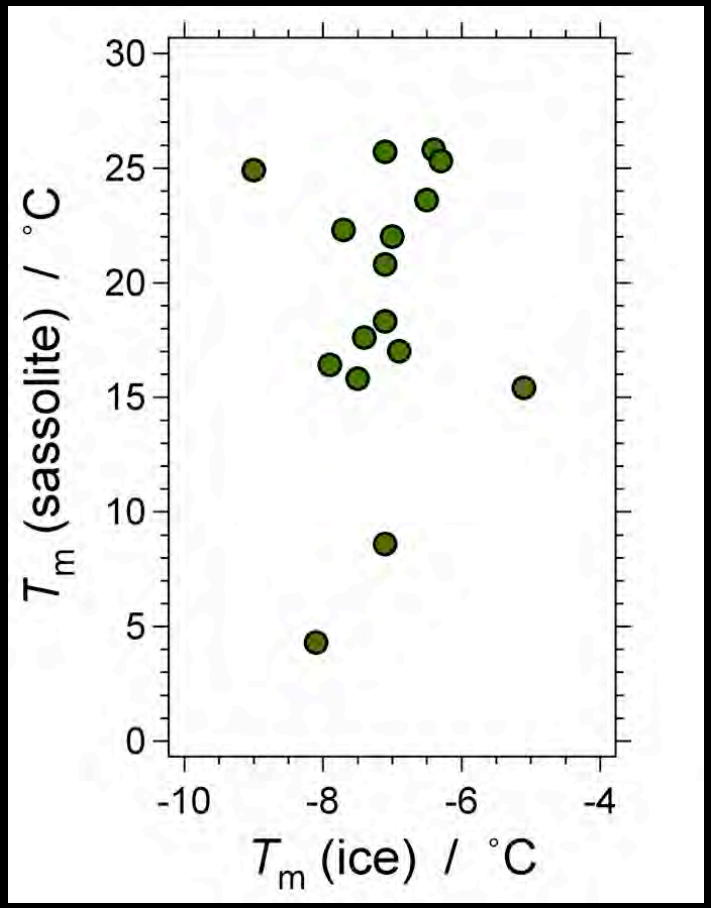
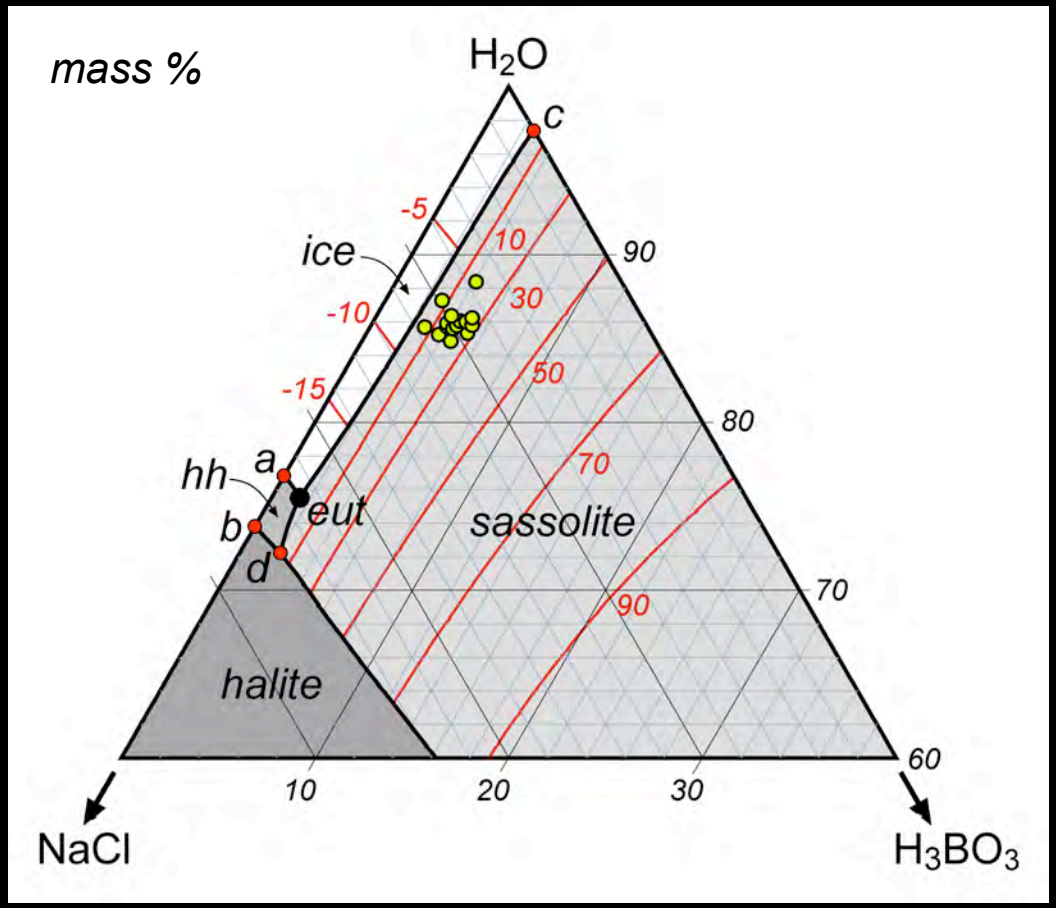
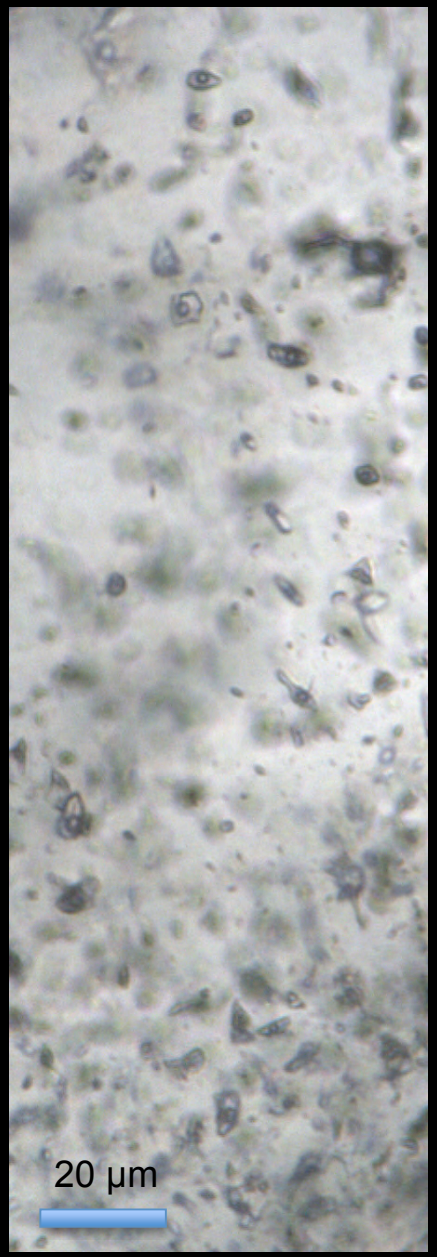
sassolite – H_3BO_3

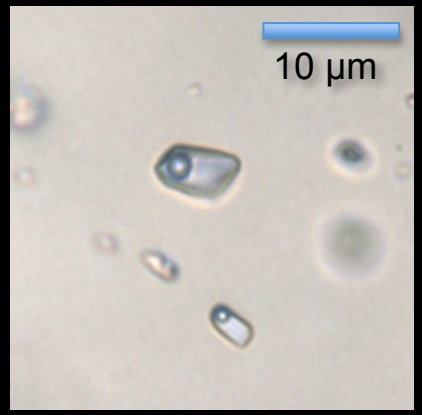


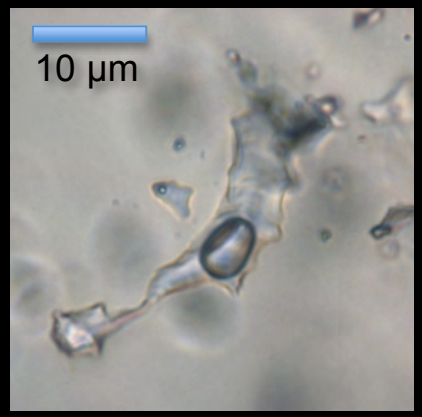


liquid phase: $w(H_2O) = 0.859 \pm 0.011$
$w(\text{NaCl-eq}) = 0.099 \pm 0.011$
$w(H_3BO_3) = 0.042 \pm 0.007$

Fluid Inclusions in Quartz







Raman vapour: $x(CO_2)$ = 0.775 – 0.989
$x(CH_4)$ = 0.017 – 0.225
low density

Raman liquid: H_2O
NaCl-eq. (aq)
H_3BO_3 (aq)

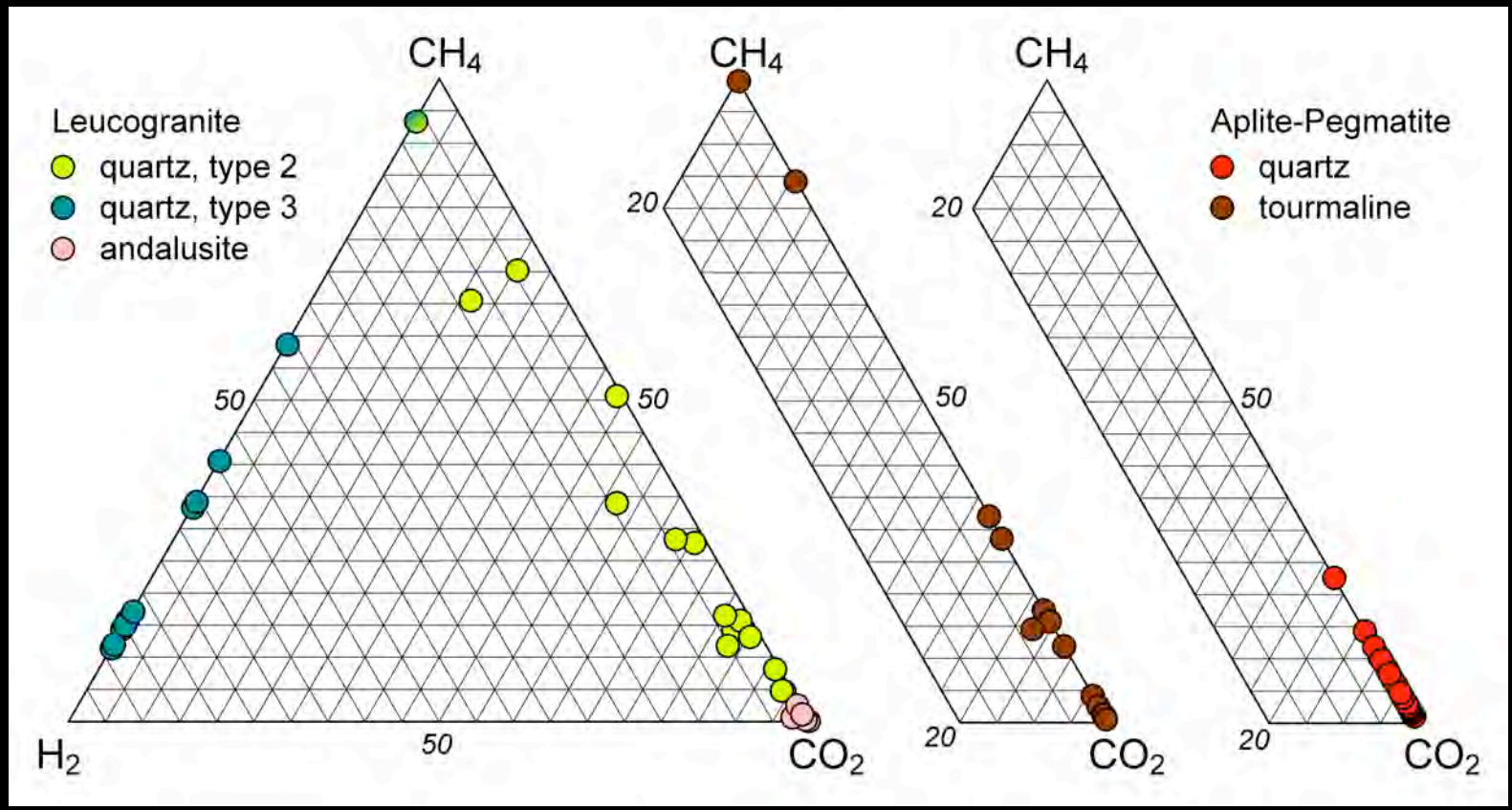
Raman included solids: mica

microthermometry T_m(ice) ≅ T_m(cla)
volume fraction φ^{vap}

bulk V_m-x properties

$x(H_2O)$ = 0.9773 ± 0.0026
$x(CO_2)$ = 0.0145 ± 0.0006
$x(CH_4)$ = 0.0002 ± 0.0001
x(NaCl) = 0.0080 ± 0.0026
V_m = 22.55 ± 0.63 $cm^3 \cdot mol^{-1}$

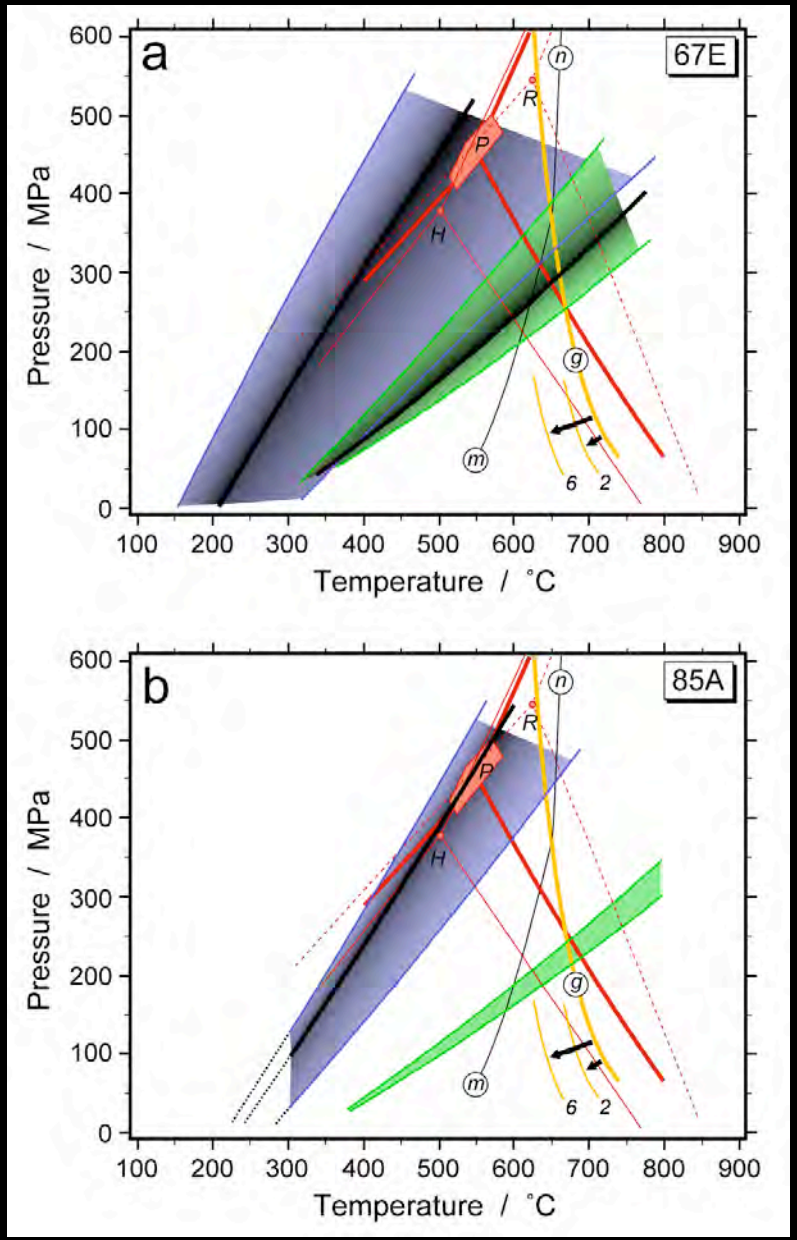
Gas composition fluid inclusions



isochore reconstruction

leucogranite dyke

pegmatite-aplite dyke



- andalusite stability field
- water saturated granite solidus
- B_2O_3
- muscovite breakdown

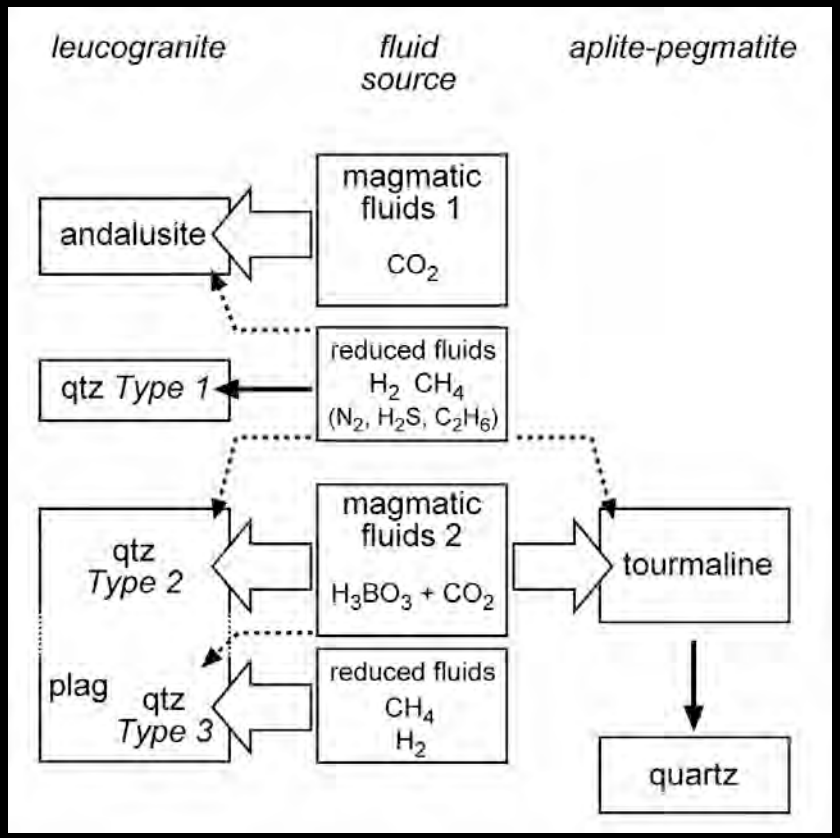
equations of state:

H_2O	*Loner HGK*
H_2O-NaCl	*AqSo DH*
H_2O-CO_2-CH_4-NaCl	*Loner AP*
H_2O-gases-NaCl	*Loner B*

http://fluids.unileoben.ac.at

Conclusions

670-720 ˚C
270-310 MPa



680-740 ˚C
250-270 MPa

250-300 ˚C
50-100 MPa

hydrothermal system
low salinity
absence of melt inclusions