

Supplementary Information

Table S1. ICP-MS analysis for REEs in the flotation feed.

Rare Earth Elements	Concentration (ppm)
Ce	3170
Dy	352
Er	227
Eu	29
Gd	336
Ho	76
La	1670
Lu	33
Nd	1380
Pr	354
Sc	15
Sm	294
Tb	55
Tm	31
Y	2233
Yb	208

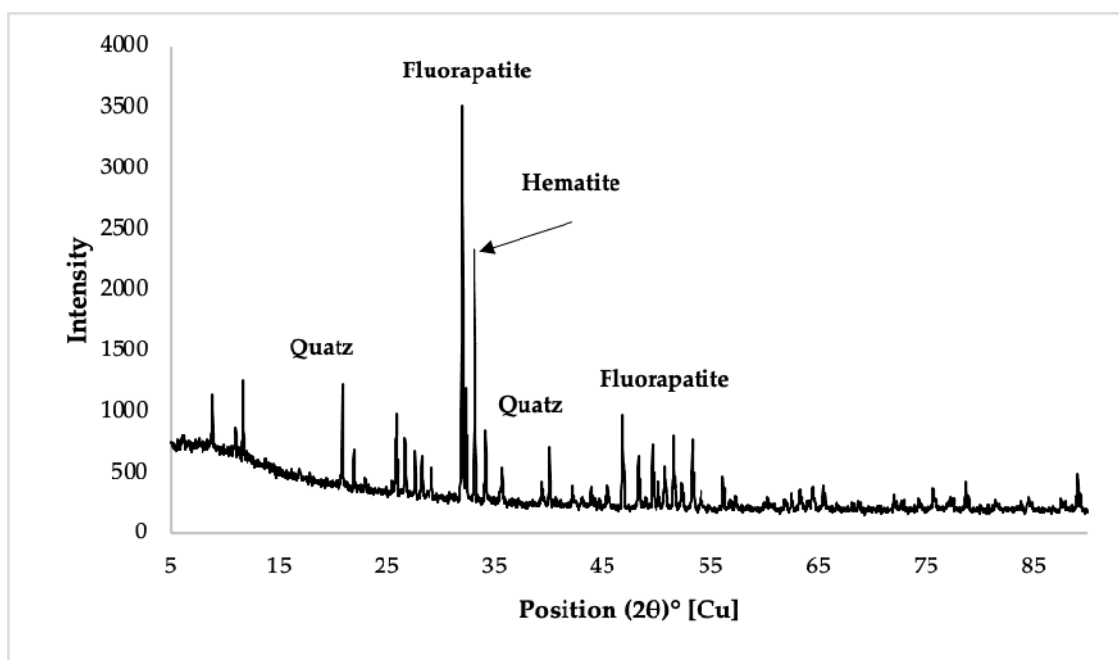


Figure S1. X-ray diffraction patterns (XRD) of the flotation feed.

Table S2. X-ray fluorescence analysis (XRF) of the flotation feed.

Oxides	Feed %
MgO	1.13
Al ₂ O ₃	2.35
SiO ₂	13.35
P ₂ O ₅	25.49
SO ₃	1.86
Cl	0.082
K ₂ O	0.592
CaO	39.69
TiO ₂	0.141
Cr ₂ O ₃	0.000198
Mn ₂ O ₃	0.225
Fe ₂ O ₃	15.04
SrO	0.00024

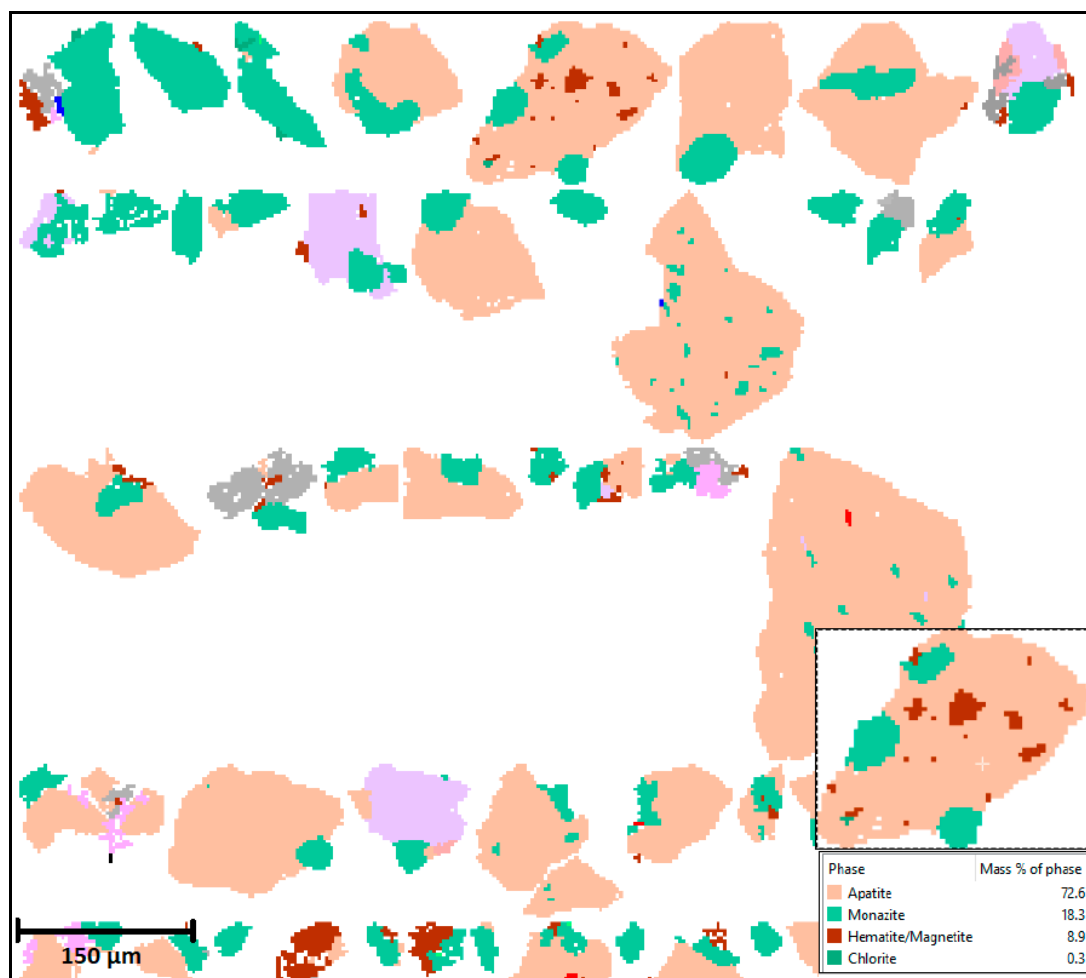


Figure S2. TIMA false-color image of selected monazite (blue-green) grains in the feed sample shows a strong association with apatite (peach).

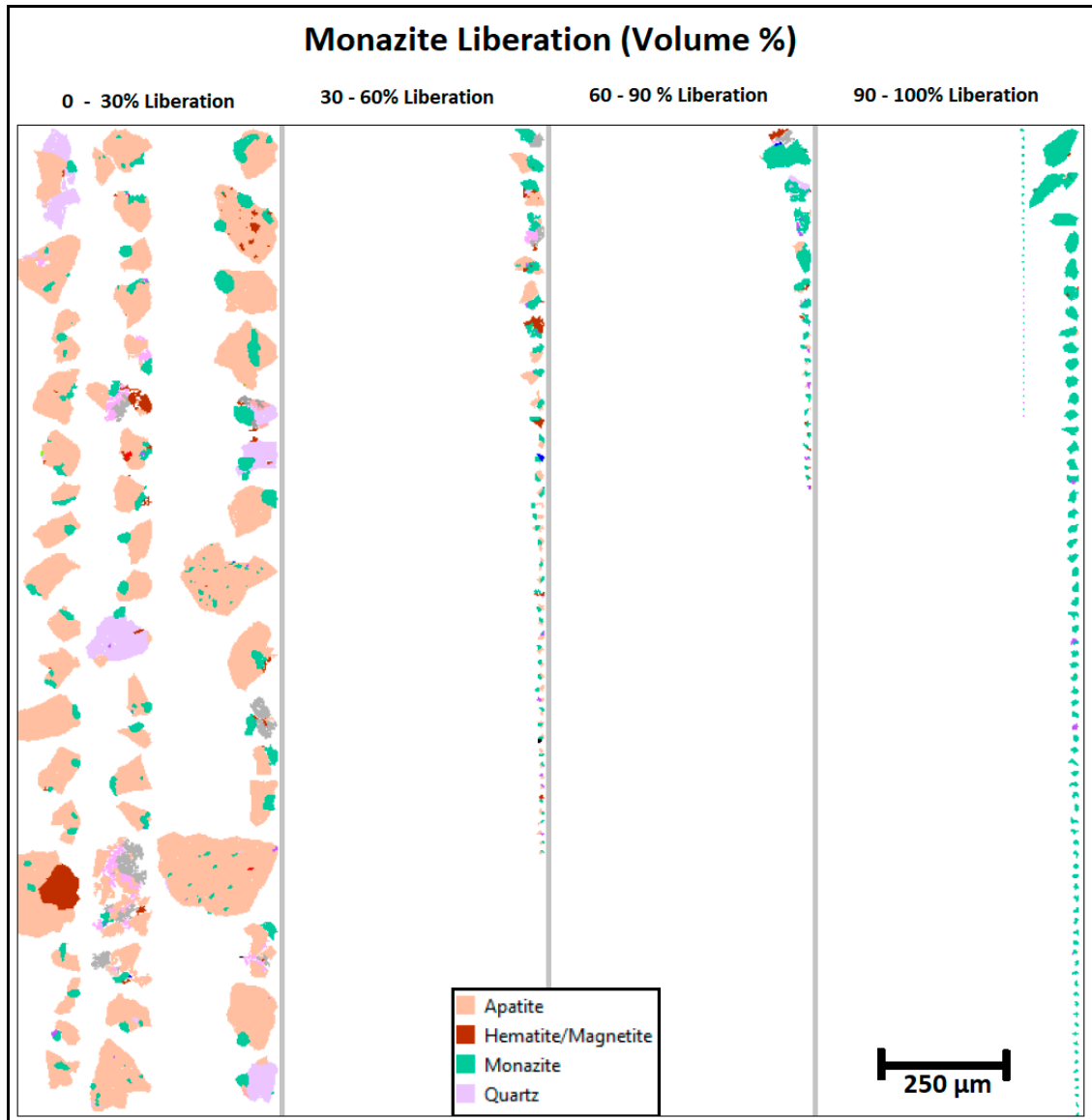


Figure S3. TIMA false-color image of monazite liberation by volume in the flotation feed. Monazite's locking to larger apatite grains is readily apparent in the 0% to 30% liberation.

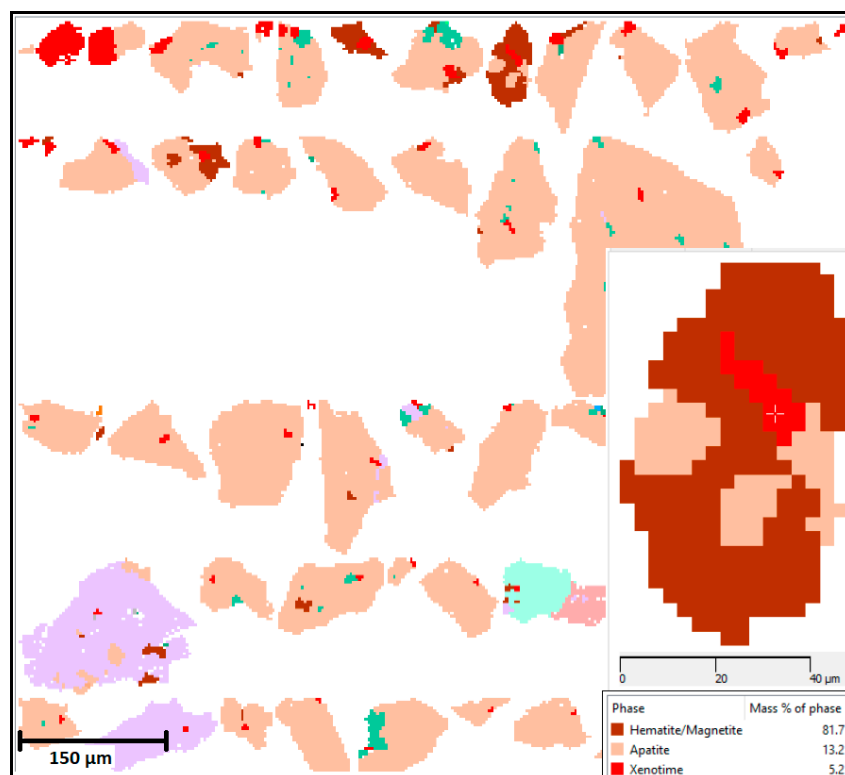


Figure S4. TIMA false-color image of selected xenotime (red) grains in the flotation feed shows a strong association with apatite (peach) and iron oxides (brown).

Table S3. Modal mineral concentrations in flotation tailings and concentrates (P—mineral detected at less than 0.01%).

Mineral	Formula	Tailing (%)	Concentrate (%)
Apatite	$\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F})$	64.5	73.5
Hematite/Magnetite	$\text{Fe}_2\text{O}_3/\text{Fe}_3\text{O}_4$	21.6	14.6
Quartz	SiO_2	6.84	4.67
K-Feldspar	KAlSi_3O_8	2.32	1.74
Fluorite	CaF_2	0.47	0.91
Monazite	$(\text{Ce},\text{La},\text{Nd})\text{PO}_4$	0.58	0.67
Biotite	$\text{K}(\text{Mg},\text{Fe})_3(\text{Al},\text{Fe})\text{Si}_3\text{O}_{10}(\text{OH})_2$	0.48	0.48
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	0.24	0.43
Amphiboles	$\text{Ca}_2(\text{Mg},\text{Fe},\text{Al})_5(\text{Al},\text{Si})_8\text{O}_{22}(\text{OH})_2$	0.44	0.42
Chlorite	$(\text{Fe},\text{Mg})_5\text{Al}(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$	0.22	0.27
Calcite	CaCO_3	0.18	0.26
Barite	BaSO_4	0.19	0.19
Garnet	$(\text{Fe},\text{Mg},\text{Ca})_3\text{Al}_2(\text{SiO}_4)_3$	0.08	0.11
Dolomite	$\text{CaMg}(\text{CO}_3)_2$	0.25	0.10

Wagnerite	$(\text{Mg,Fe})_2(\text{PO}_4)\text{F}$	0.06	0.09
Muscovite	$\text{KAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2$	0.06	0.09
Plagioclase	$\text{Na}_{0.5-0.3}\text{Ca}_{0.5-0.7}\text{Al}_{1.5-1.7}\text{Si}_{2.5-2.3}\text{O}_8$	0.28	0.09
Talc	$\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$	0.09	0.07
Pyrite	FeS_2	0.19	0.06
Jarosite	$\text{KFe}(\text{SO}_4)_2(\text{OH})_6$	0.09	0.04
Isokite	$\text{CaMg}(\text{PO}_4)\text{F}$	0.09	0.03
Pyroxenes	$(\text{Ca,Mg,Fe})\text{Si}_3\text{O}_6$	0.12	0.03
Thadeuite	$(\text{Ca,Mn})(\text{Mg,Fe,Mn})_3(\text{PO}_4)_3(\text{OH,F})_2$	0.02	0.03
Magniotriplite	$(\text{Mg,Fe,Mn})_2(\text{PO}_4)\text{F}$	0.05	0.03
Lizardite	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$	0.09	0.02
Rutile	TiO_2	0.02	0.02
Spinel	MgAl_2O_4	0.01	0.02
Xenotime	YPO_4	0.01	0.01
Kaolinite	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_2$	0.03	0.01
Epidote	$\text{Ca}_2\text{Al}_2\text{Fe}(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$	P	0.01
Allanite	$(\text{Ca,Ce})_2(\text{Al,Fe})_3(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$	0.01	0.01
Titanite	CaTiSiO_5	P	0.01
Synchysite	$\text{Ca}(\text{Ce,L,Nd})(\text{CO}_3)_2\text{F}$	P	0.01
Tourmaline	$\text{Na}(\text{Al,Li})_3\text{Al}_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{OH})_4$	0.03	P
Ilmenite	FeTiO_3	0.01	P

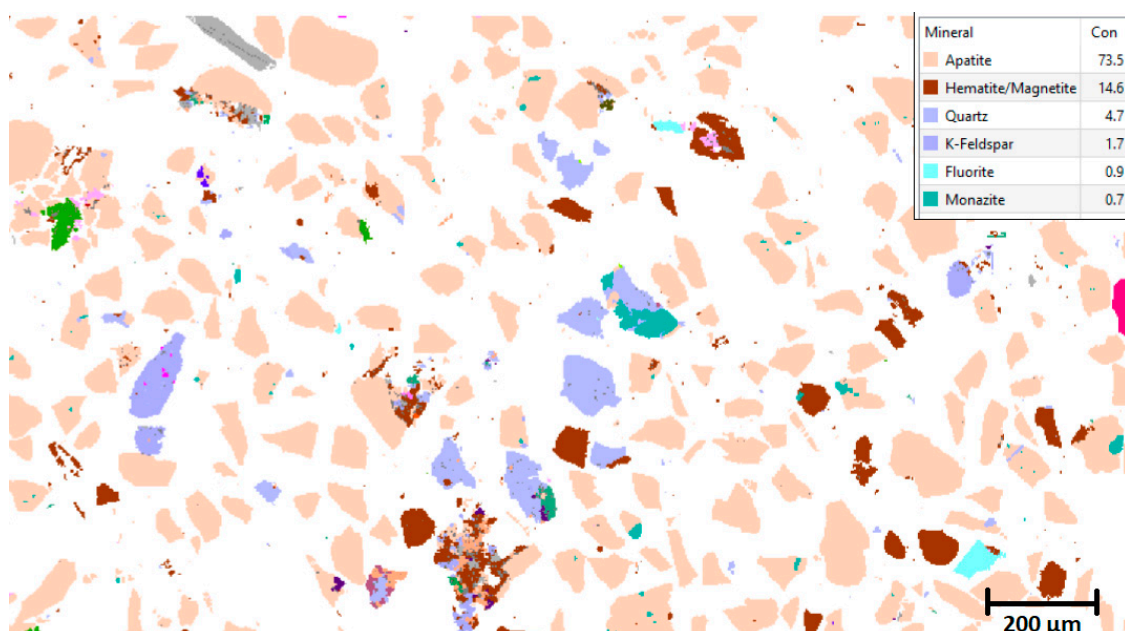


Figure S5. False-color TIMA image shows mineral associations in the flotation concentrate (chitosan was used as a depressant at 150g/t). Monazite (blue-green) is seen as large grains attached primarily to apatite grains.

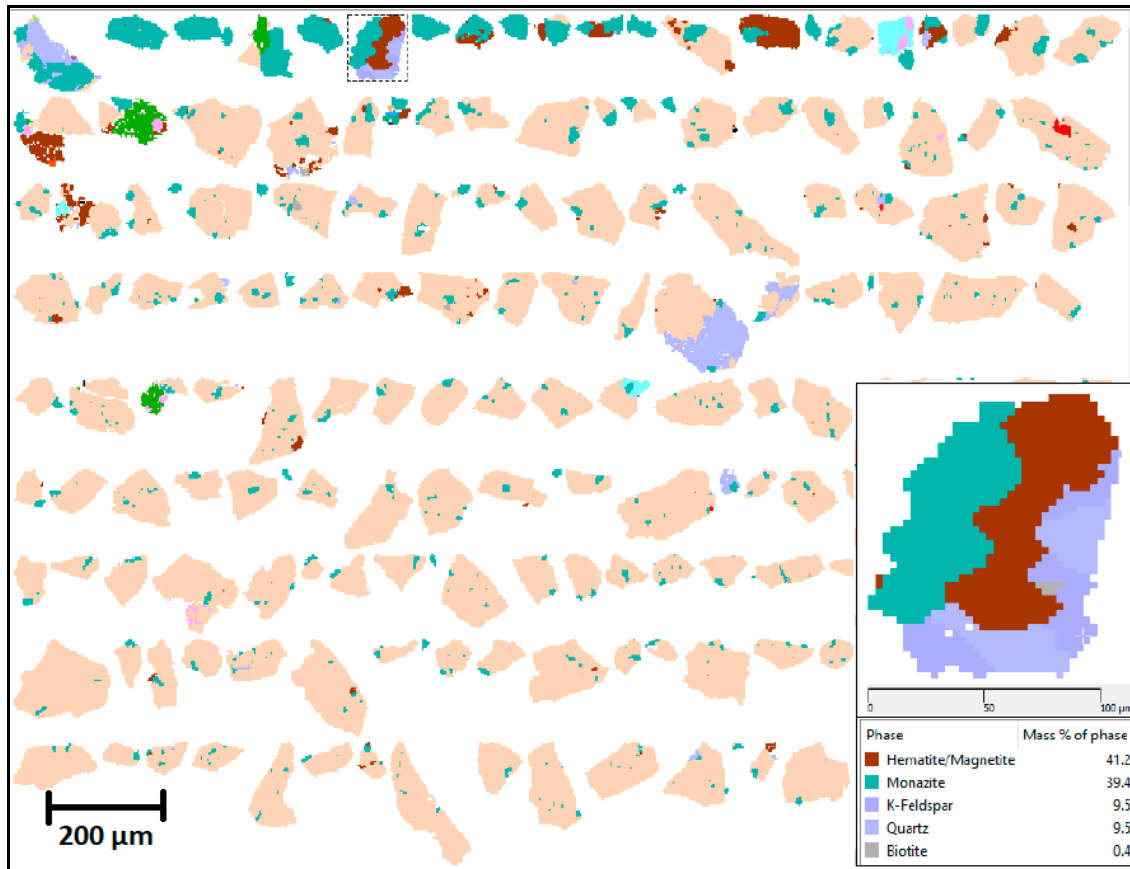


Figure S6. Selected monazite (blue-green) grains in the flotation concentrates (chitosan was used as a depressant at 150g/t) shows a strong association with apatite (peach) in TIMA false-color image.