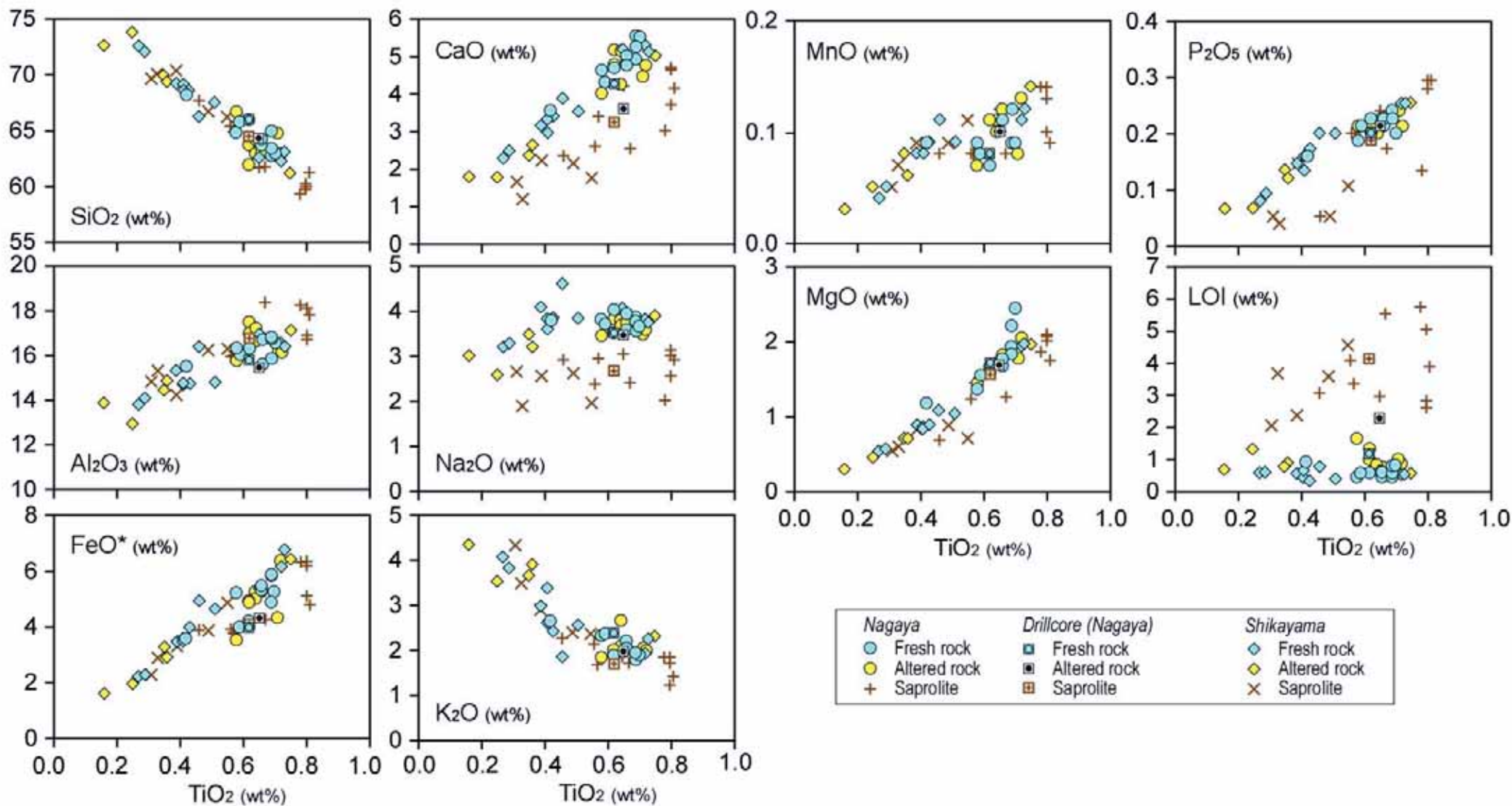
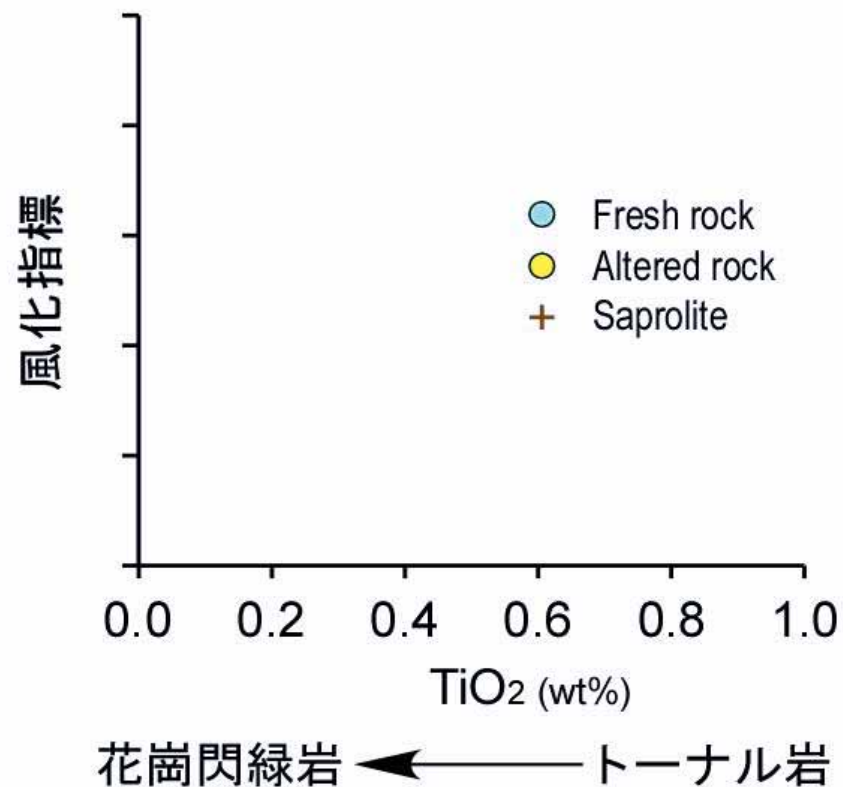
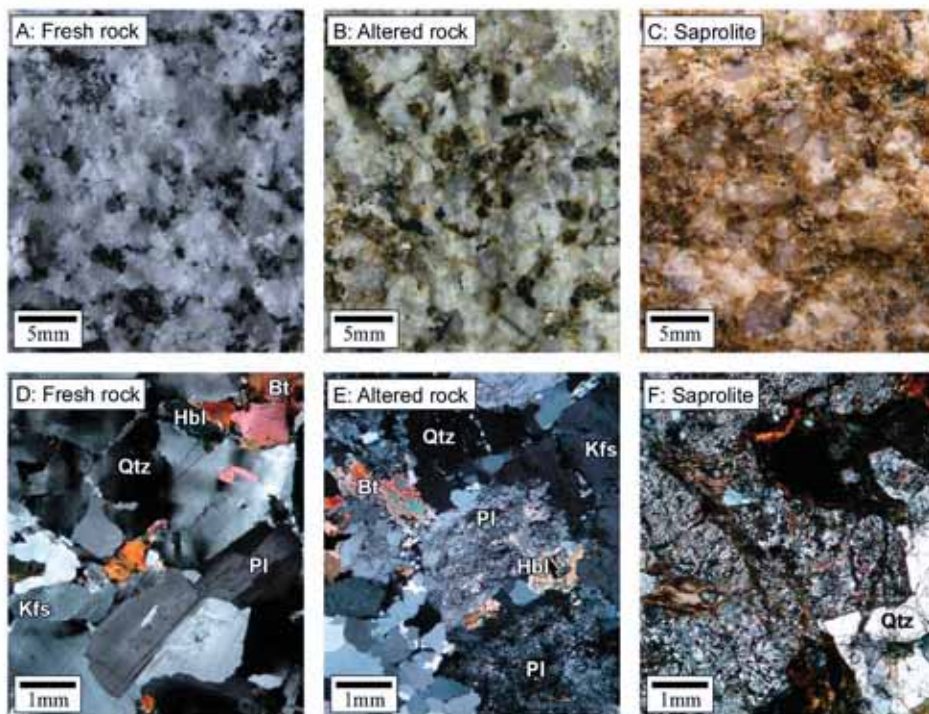


マグマの変化検討 TiO₂を軸に 新鮮～風化岩



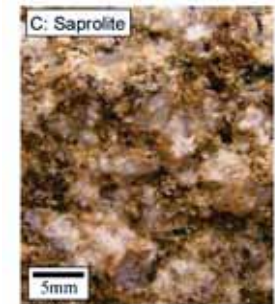
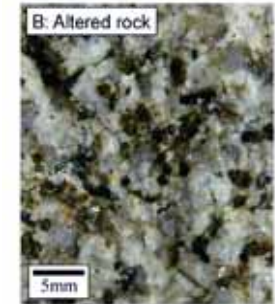
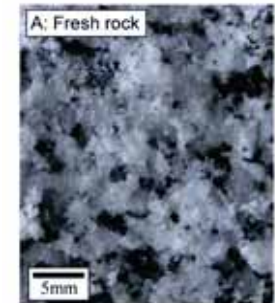
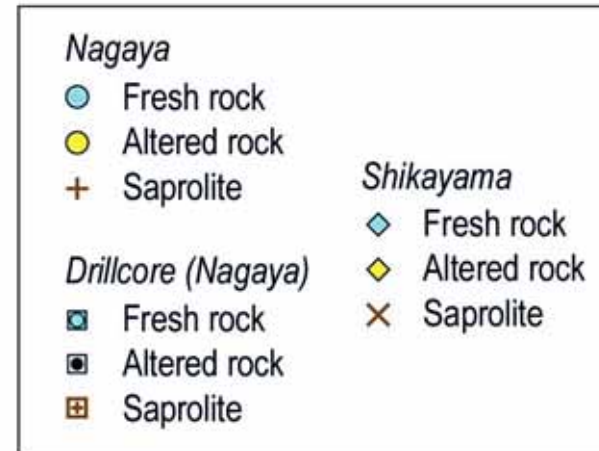
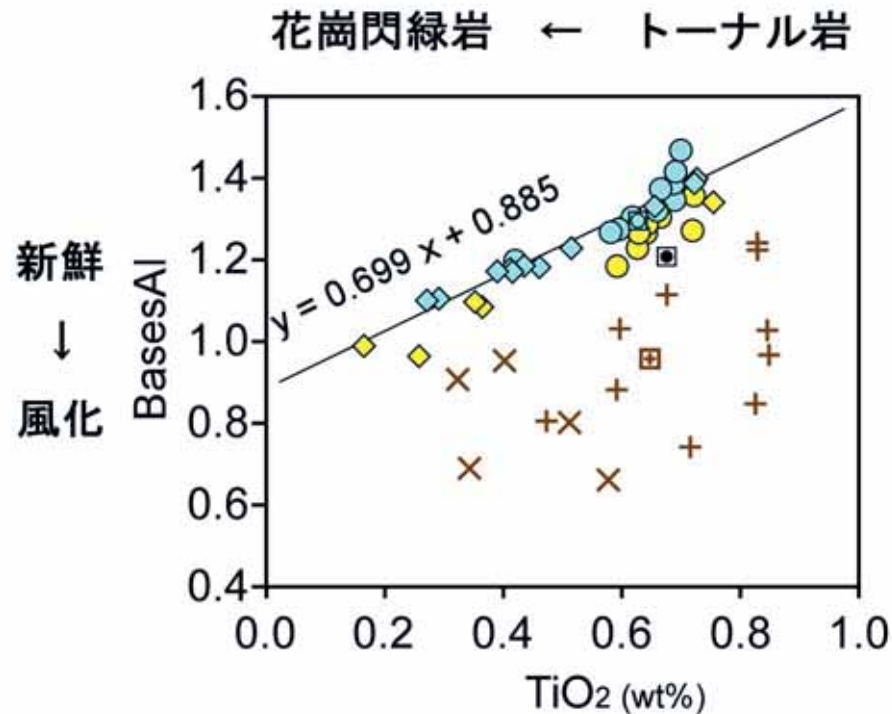
TiO₂を使い、マグマの変化が 風化指標へ与える影響を見る



TiO₂ vs 風化指標 (Bases Al)

$$\text{BasesAl (Bases to Alumina ratio)} = \frac{\text{CaO} + \text{Na}_2\text{O} + \text{MgO} + \text{K}_2\text{O}}{\text{Al}_2\text{O}_3}$$

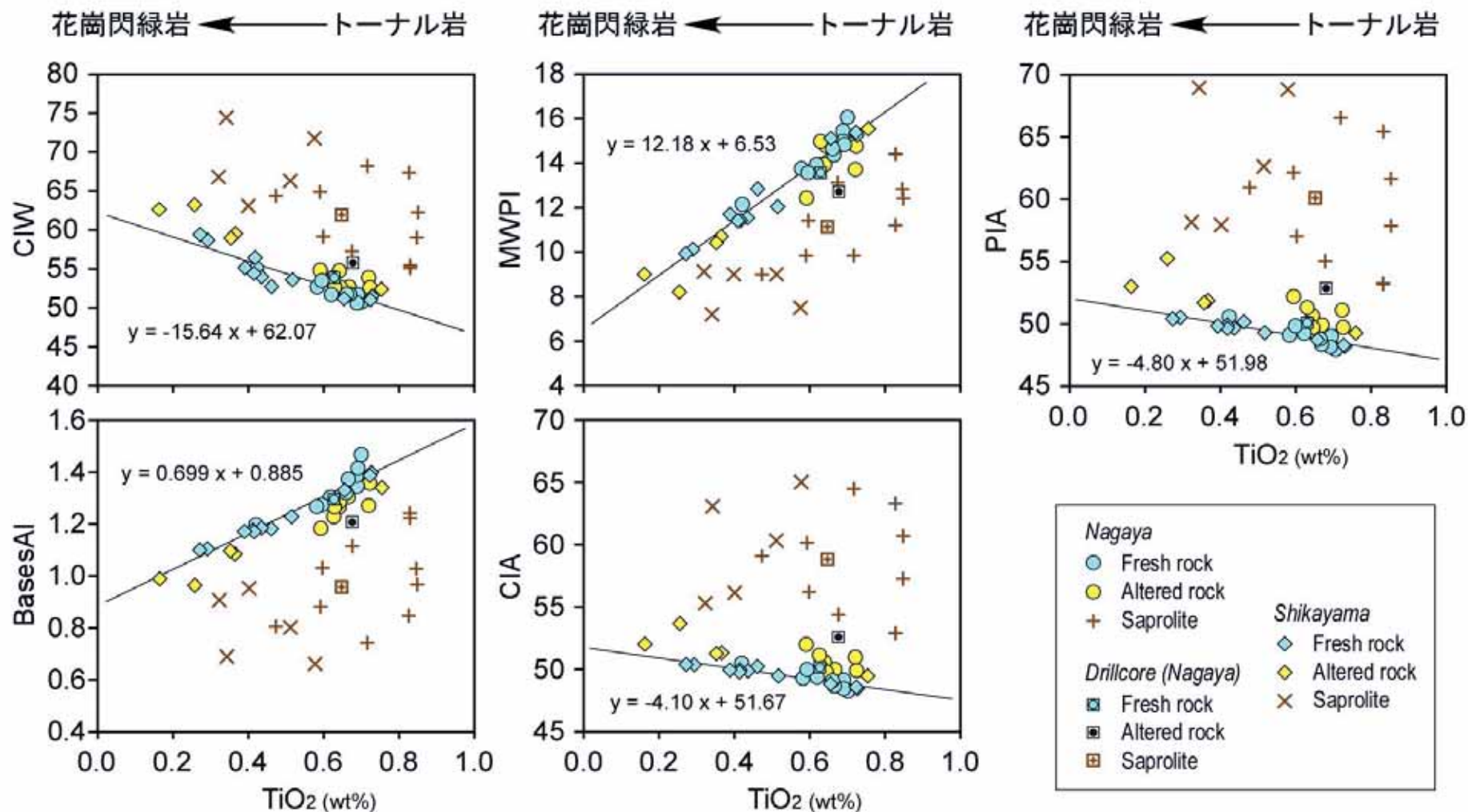
Colman (1982)



新鮮な岩石は分化するほど風化度が上昇

マグマの組成変化を風化指標から除去する必要がある

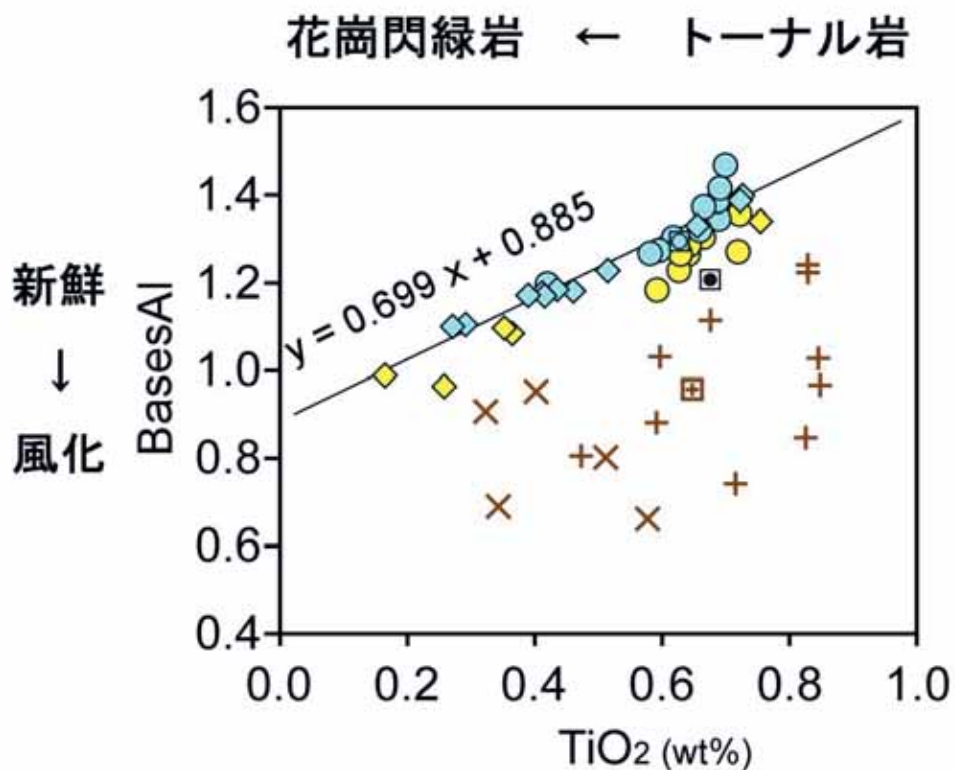
TiO₂ vs 風化指標 (他の例)



従来指標の問題点

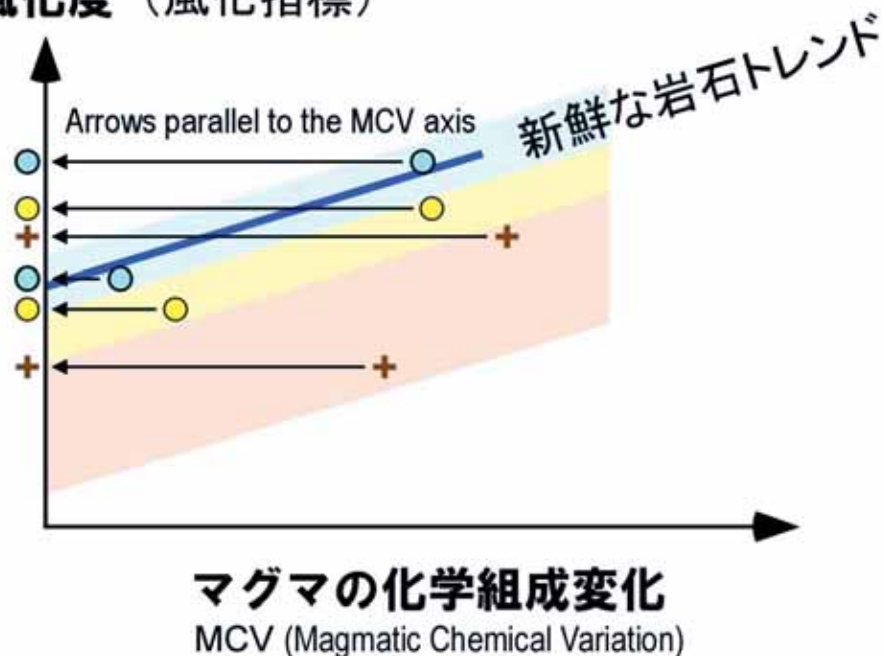
$$\text{BasesAl (Bases to Alumina ratio)} = \frac{\text{CaO} + \text{Na}_2\text{O} + \text{MgO} + \text{K}_2\text{O}}{\text{Al}_2\text{O}_3}$$

Colman (1982)



DCW (Degree of Chemical Weathering)

風化度 (風化指標)

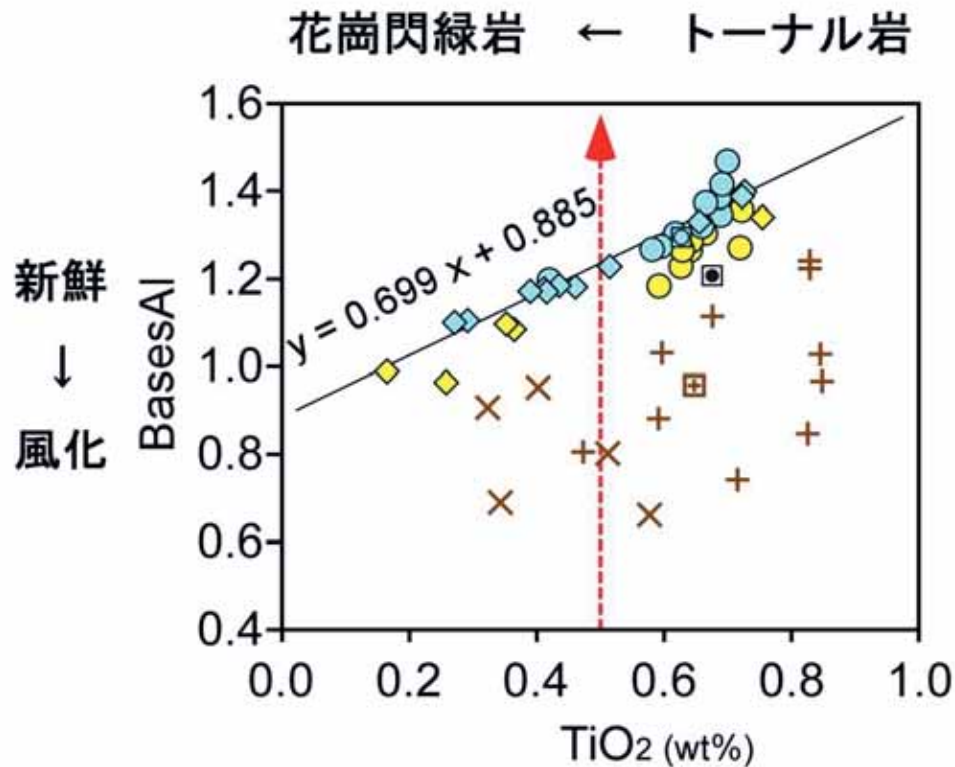


マグマの組成変化を考慮せず、「風化度」を測定してしまう。

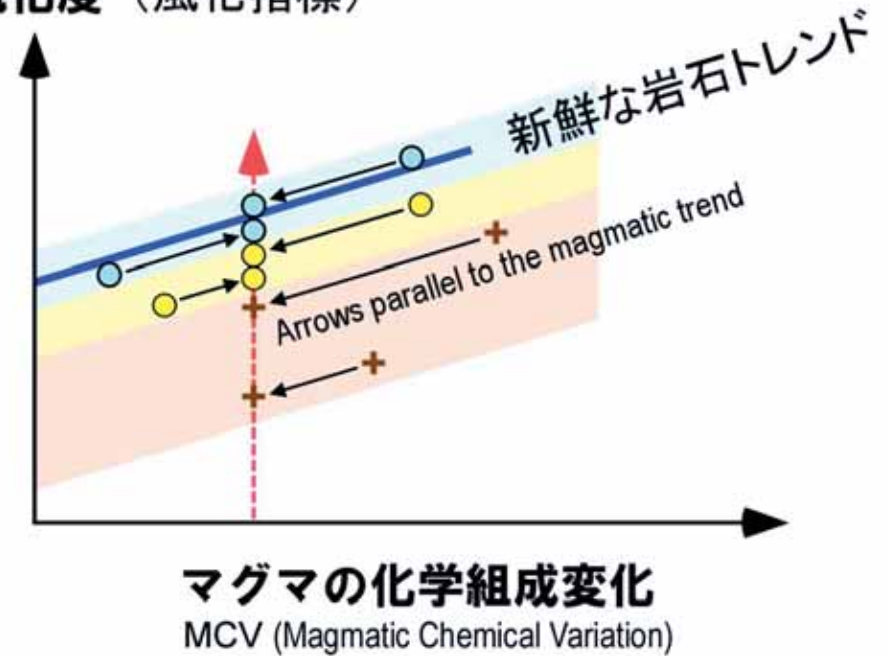
解決モデル

$$\text{BasesAl (Bases to Alumina ratio)} = \frac{\text{CaO} + \text{Na}_2\text{O} + \text{MgO} + \text{K}_2\text{O}}{\text{Al}_2\text{O}_3}$$

Colman (1982)



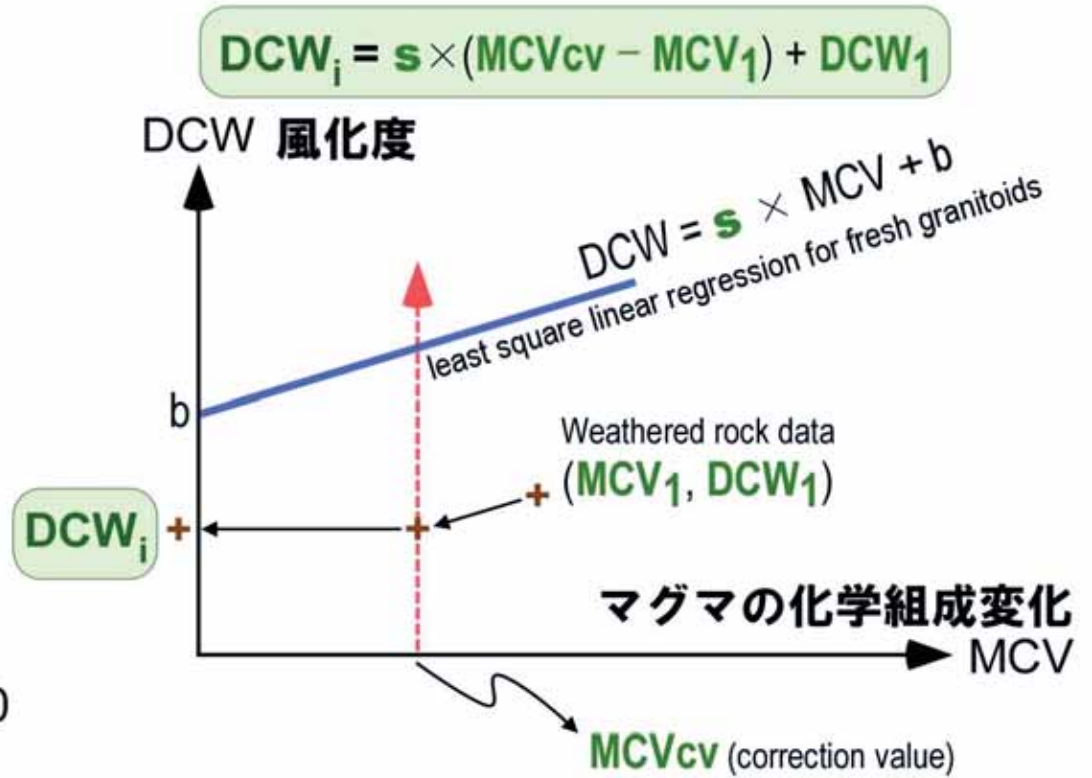
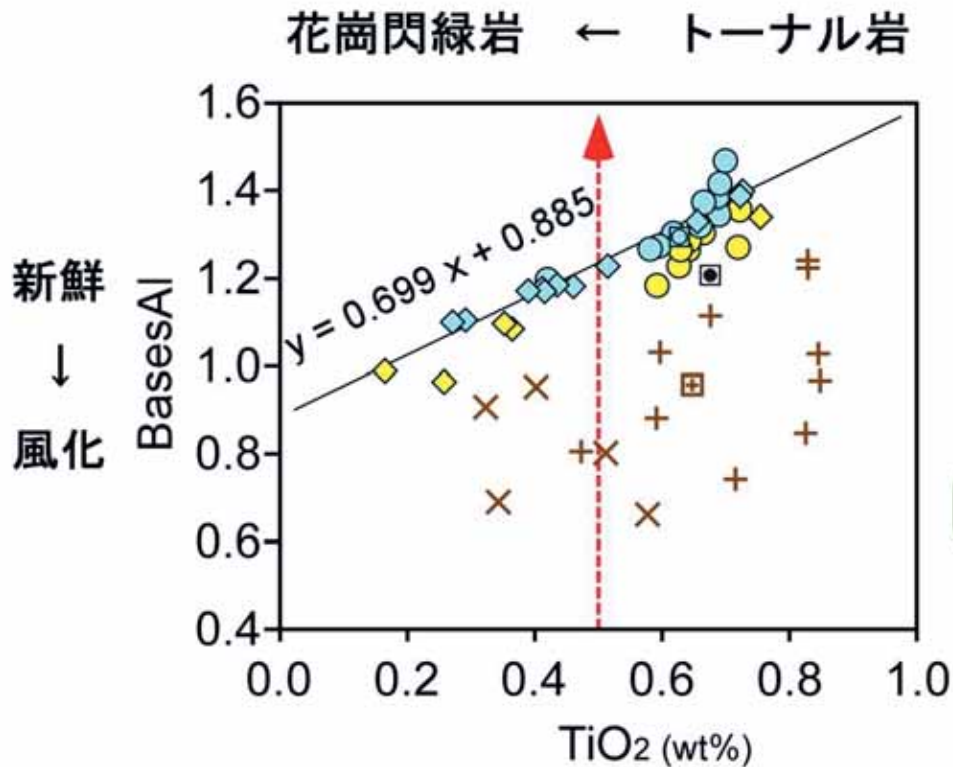
DCW (Degree of Chemical Weathering)
風化度 (風化指標)



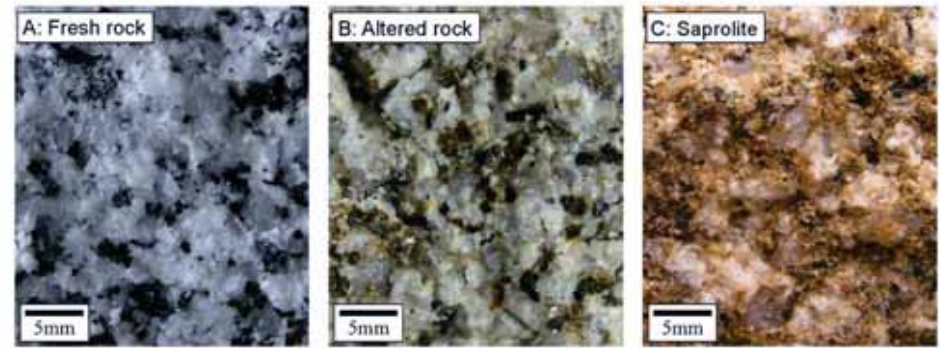
1. 新鮮な岩石のトレンドの midpoint に X 軸に対して垂直の補助線を引く
2. 各試料のポイントを「トレンドに平行移動」させて補助線へ集める

計算方法

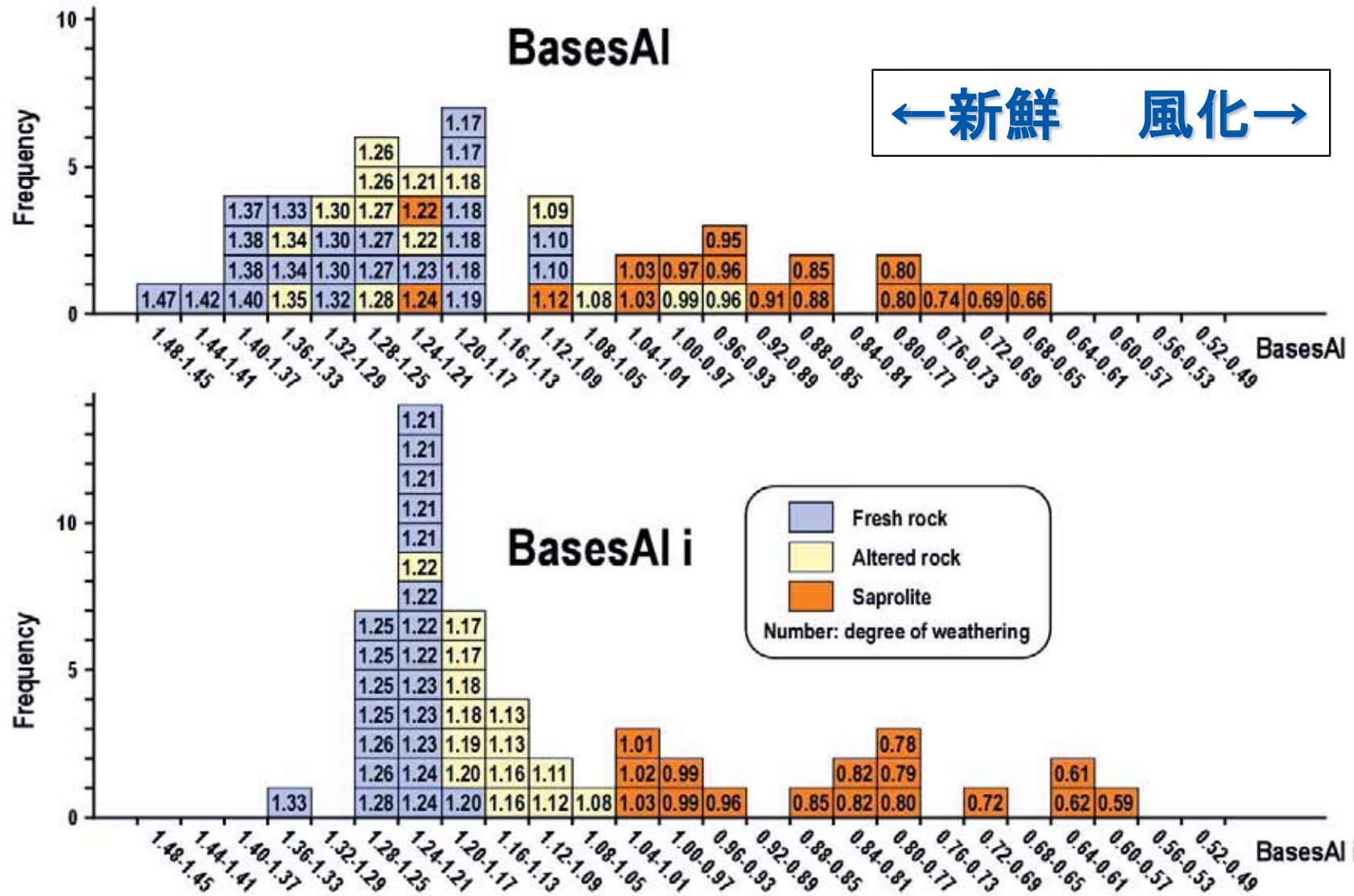
$$\text{BasesAl (Bases to Alumina ratio)} = \frac{\text{CaO} + \text{Na}_2\text{O} + \text{MgO} + \text{K}_2\text{O}}{\text{Al}_2\text{O}_3} \quad \text{Colman (1982)}$$



BasesAl vs BasesAl i

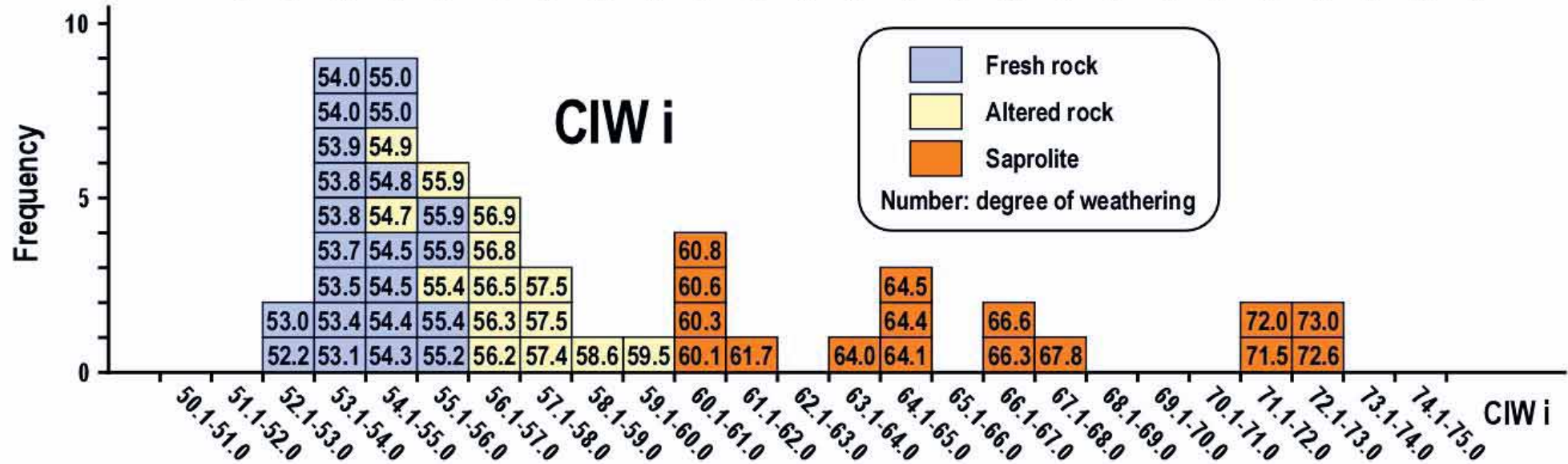
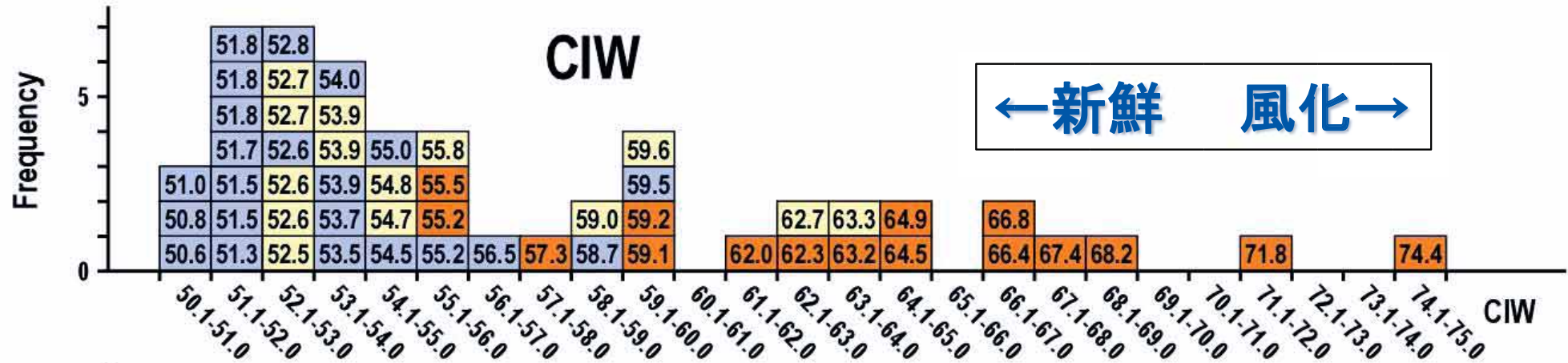
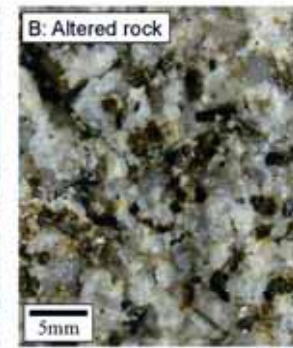
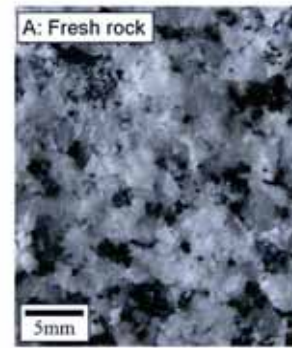


BasesAl (Bases to Alumina ratio) = $\frac{\text{CaO} + \text{Na}_2\text{O} + \text{MgO} + \text{K}_2\text{O}}{\text{Al}_2\text{O}_3}$ Colman (1982)



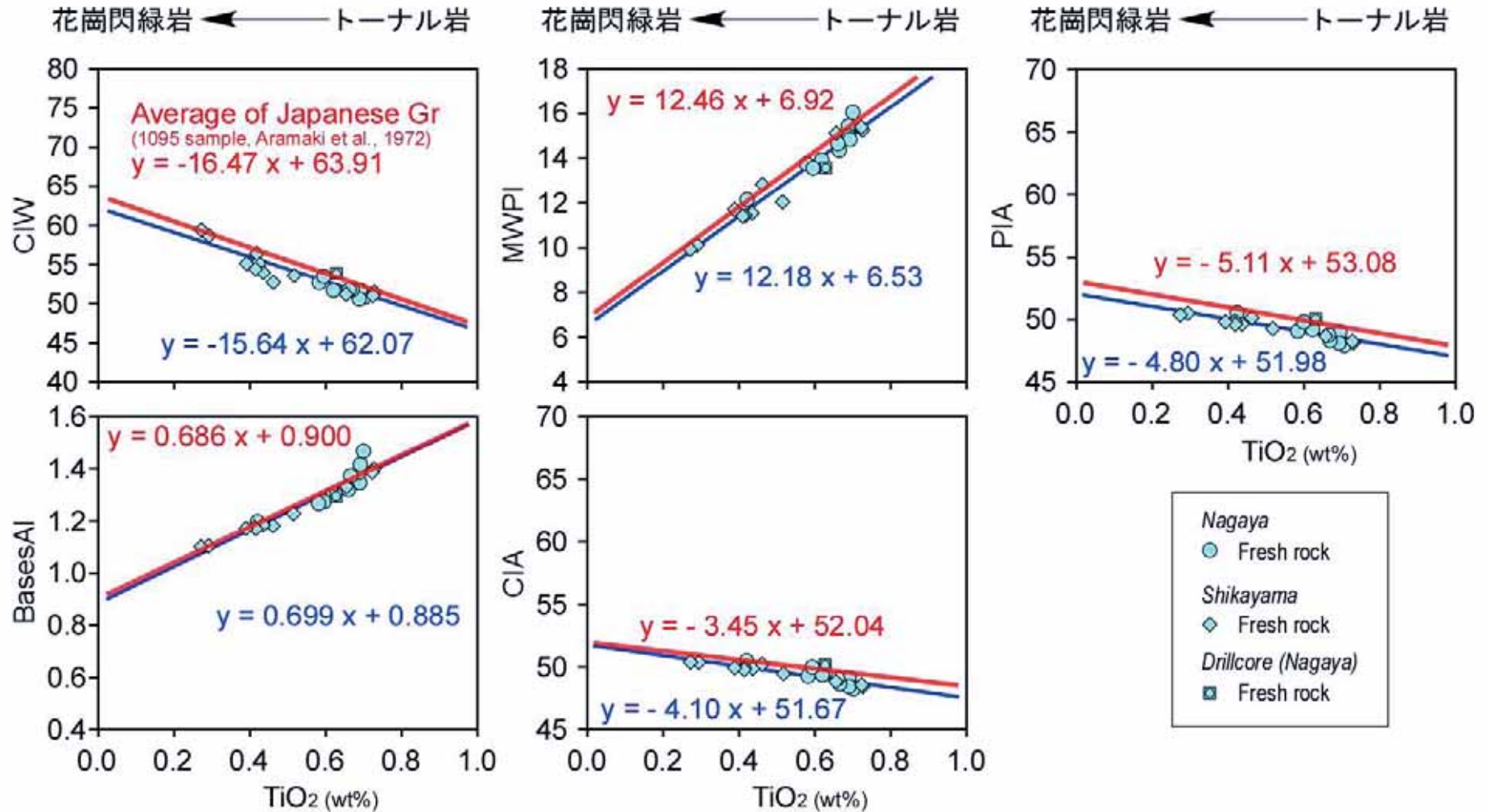
CIW vs CIW i

$$\text{CIW (Chemical Index of Weathering)} = \frac{\text{Al}_2\text{O}_3}{\text{Al}_2\text{O}_3 + \text{CaO} + \text{Na}_2\text{O}} \times 100 \quad \text{Harnois (1988)}$$



新鮮な岩石のトレンドは日本の花崗岩の平均を使おう

日本の花崗岩の平均組成: Aramaki et al. (1972, 1095sample)



Degree of weathering of the Abukuma granitoids based on the classical methods and the improved methods.

A: Classical methods					
	CIW	MWPI	BasesAl	CIA	PIA
Fresh rock	50.6-59.5	16.0-9.9	1.47-1.10	48.2-50.4	48.0-50.5
Average	53.3	13.3	1.28	49.4	49.3
SD (1s)	2.4	1.8	0.11	0.7	0.8
Altered rock	52.5-63.3	15.5-8.2	1.35-0.96	49.4-53.6	49.3-55.3
Saprolite	55.2-74.4	14.4-7.2	1.24-0.66	52.9-65.0	53.2-69.0

B: Improved methods based on fresh Abukuma granitoids					
	CIW_i	MWPI_i	BasesAl_i	CIA_i	PIA_i
Fresh rock	52.2-55.9	13.6-11.8	1.33-1.20	49.1-50.6	49.0-50.7
Average	54.2	12.6	1.23	49.6	49.6
SD (1s)	0.9	0.4	0.03	0.4	0.4
Altered rock	54.7-59.5	13.3-10.6	1.22-1.08	50.3-53.2	50.4-54.1
Saprolite	60.1-73.0	11.2-6.6	1.03-0.59	54.2-65.4	54.8-69.2

C: Improved methods based on average I- and S-type Japanese granitoids					
	CIW_i	MWPI_i	BasesAl_i	CIA_i	PIA_i
Fresh rock	52.2-56.0	13.5-11.8	1.33-1.21	48.9-50.5	49.0-50.7
Average	54.3	12.6	1.24	49.6	49.6
SD (1s)	0.9	0.4	0.03	0.4	0.4
Altered rock	54.8-59.3	13.2-10.5	1.22-1.08	50.2-53.1	50.4-54.0
Saprolite	60.2-73.0	11.3-6.6	1.03-0.59	54.0-65.3	54.9-69.3

SD: standard deviation.

マグマ成因論 (理学) と風化指標 (応用) の融合

風化指標完成 (日本の花崗岩の平均使用)

$$CIW_i = -16.47 \times (0.5 - TiO_2) + CIW$$

$$CIW = \frac{Al_2O_3}{Al_2O_3 + CaO + Na_2O} \times 100 \quad \text{Harnois (1988)}$$

$$MWPI_i = 12.46 \times (0.5 - TiO_2) + MWPI$$

$$MWPI = \frac{CaO + Na_2O + MgO + K_2O}{SiO_2 + Al_2O_3 + Fe_2O_3 + CaO + Na_2O + MgO + K_2O} \times 100 \quad \text{Vogel (1975)}$$

$$BasesAl_i = 0.686 \times (0.5 - TiO_2) + BasesAl$$

$$BasesAl = \frac{CaO + Na_2O + MgO + K_2O}{Al_2O_3} \quad \text{Colman (1982)}$$

$$CIA_i = -3.45 \times (0.5 - TiO_2) + CIA$$

$$CIA = \frac{Al_2O_3}{Al_2O_3 + CaO^* + Na_2O + K_2O} \times 100 \quad \text{Nesbitt and Young (1982)}$$

$$PIA_i = -5.11 \times (0.5 - TiO_2) + PIA$$

$$PIA = \frac{Al_2O_3 - K_2O}{Al_2O_3 + CaO^* + Na_2O - K_2O} \times 100 \quad \text{Fedo et al. (1995)}$$

結論: 風化岩石の主成分化学組成を上記の式に入れるだけで
マグマの成因による組成変化を除去した化学的風化度
を測定できる.

- ✓ 花崗岩の化学的風化度を的確に数値化
- ✓ 地質専門でない技術者に扱いやすい
- ✓ 安価かつ迅速