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Abstract

Soil susceptibility reflects geological situation of districts. In Japanese Islands, Kansai and Shikoku districts where no volcano can be seen in Quaternary period, have low soil susceptibility averaged 4.3x10^{-4} SI, whereas other districts where active volcanoes are situated have high soil susceptibility averaged about 5.1x10^{-3} SI.

Keywords: susceptibility, soil, Japan

1. Introduction

In European countries, e.g. in Czech Republic, Germany and U.K., susceptibility of the earth surface materials has been measured for environmental and pollution study (e.g. DEARING et al, 1996: HAY et al, 1997: GEORGEAUD et al, 1997: STRTZYSZCZ et al, 1998: DEARING, 1999: HOFFMANN et al, 1999: PETROVSKY et al, 2000). Susceptibility is proportional mainly to the amount of ferrimagnetic minerals. As small particles of ferrimagnetic minerals are produced from burning of fossil fuel, and industrial factories, road traffic that runs with fossil fuel might increase susceptibility of the surface materials of earth. In this study, soil susceptibility was measured to get primitive data for pollution study in Japan.

2. Measurement and result

Measurement was performed using SM 20 made by ZH instruments. About 60 measuring points were widely spread from Hokkaido district to Kyushu district. In Table 1, description of the measuring points with averaged data is shown. Mean of the average calculated in every district is listed in Table 2.

Abnormal data rejected from compilation is listed in Table 3. They include under cliff in Muroran City that is famous for iron industry, and near the active volcanoes where sulfur gas is carrying out.

Fig. 1-1 is the compilation of all the raw data. As Japanese Islands situate in long longitude and latitude, the axis of abscissa also shows the location from north to south.

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Table 1 Measuring points with average of data.

Susx10^{-3}SI

	Lat.	Long.	Prefecture or city		Data number	Range of data	Average±std
Hokkaido	42.93	141.42	Sapporo	札幌市内	29	4.18-18.0	9.12±3.63
	42.83	141.25	Sapporo	定山渓	8	4.31-8.18	6.29±1.24
	43.08	140.97	Otaru	小樽市内	42	2.34-17.4	5.93±3.32
	43.50	141.05	Otaru	銭函町	4	8.18-12.1	10.13±2.00
	42.67	140.97	Kimobetu	中山峠	4	4.37-6.84	5.91±1.07
	42.42	140.75	Soubetu	洞爺	12	3.47-17.4	10.40±4.50
	42.17	140.77	Muroran	室蘭市内	63	4.18-17.6	9.98±3.69
Tohoku	40.87	141.13	Aomori	野辺地町	2	5.24-5.41	5.33±0.08
	41.30	140.80	Aomori	仏が浦	4	1.29-4.02	2.60±1.39
	41.12	140.80	Aomori	脇野沢村	2	6.40-8.42	7.41±1.01
	41.25	140.33	Aomori	竜飛岬	4	8.29-11.6	9.87±1.42
	40.90	140.43	Aomori	金木町斜陽館	3	3.61-5.65	4.93±1.14
	39.50	140.53	Aomori	白神山地	8	0.184-3.03	1.28±1.03
	39.60	140.57	Kakunodate	角館町	11	1.98-5.23	3.13±0.93
	39.70	141.17	Morioka	盛岡市内	17	1.56-8.65	4.24±1.89
Kanto	36.73	139.62	Totigi	日光東照宮	12	1.03-11.0	6.23±3.95
	35.82	139.60	Saitama	朝霞市東洋大学	13	2.38-9.02	5.35±2.01
	35.77	139.67	Tokyo	練馬光が丘公園	6	2.62-8.65	5.28±2.24
	35.67	139.70	Tokyo	代々木公園	12	6.05-9.54	7.87±1.09
	35.65	139.62	Tokyo	世田谷上北沢	7	5.60-8.19	6.83±1.10
	35.53	139.75	Kanagawa	川崎江川公園	14	3.18-4.02	3.66±0.37
	35.53	139.75	Kanagawa	川崎大師	12	6.05-9.81	7.29±1.16
	35.27	139.42	Kanagawa	葉山堀内(庭)	3	1.90-3.78	2.60±1.03
	35.70	139.50	Tokyo	小金井(寺、公園)	12	3.40-8.72	6.51±1.74
	35.80	139.43	Saitama	小手指	4	5.10-6.87	5.67±0.81
	36.00	139.24	Saitama	高坂SA	4	3.12-8.68	5.53±2.35
	36.07	138.93	Saitama	長瀞町	4	3.51-5.02	4.14±0.65
	35.58	140.14	Tiba	千葉中央区港町	29	4.84-13.2	7.40±2.39
	35.63	140.05	Tiba	千葉大医学部	16	4.42-11.8	7.96±2.39
	35.43	139.38	Kanagawa	相模大橋	4	5.84-10.8	8.24±2.73
	35.77	139.63	Tokyo	板橋赤塚新町	4	6.24-7.77	6.93±0.66
	34.97	138.43	Shizuoka	日本平SA	2	2.05-2.87	2.46±0.41
	35.45	139.40	Kanagawa	海老名SA	2	5.05-5.77	5.41±0.36
Tyubu1	36.43	138.52	Gunma	浅間鬼押出、平原	6	3.01-4.71	3.78±0.72
	36.53	138.57	Gunma	浅間観音堂	6	8.67-13.3	11.35±1.64
	36.57	138.58	Gunma	きゃべつ畑	2	6.65-7.21	6.93±0.28
	36.62	138.60	Gunma	草津白根	8	1.18-4.25	2.93±1.14
	37.30	138.62	Niigata	塩沢石打SA	4	1.83-5.97	3.74±1.84
Tyubu 2	36.15	136.17	Hukui	福井足羽公園	9	0.463-4.51	2.29±1.58
北陸、中京	36.23	136.27	Hukui	丸岡城	5	1.23-3.86	2.62±1.00
	36.75	137.00	Toyama	高岡古城公園	10	0.36-2.05	1.20±0.58
	37.27	137.87	Niigata	名立谷浜SA	5	1.25-3.42	2.24±0.91
	35.02	137.17	Aiti	上郷SA	6	0.718-1.44	0.894±0.458
	35.62	136.42	Gihu	根尾村	5	0.823-2.16	1.46±0.56
	35.50	136.20	Shiga	賤岳SA	4	0.286-1.21	0.641±0.402

(continued)

Measuring points with average data Susx10^{-3}SI

	Lat.	Long.	Prefecture or city		Data number	Range of data	Average±std
Kansai	35.02	135.85	Kyoto	清水寺	4	0.205-0.563	0.369±0.147
	34.70	135.50	Osaka	大阪北浜	2	0.265-0.316	0.291±0.026
	34.47	135.87	Nara	段山神社	6	0.259-0.359	0.306±0.042
	34.52	135.92	Nara	長谷寺	10	0.084-0.381	0.186±0.099
	34.53	136.28	Nara	室生寺	8	0.274-0.989	0.555±0.234
Sikoku	34.22	133.90	Kagawa	綾南町	8	0.172-0.237	0.186±0.035
	34.33	134.07	Kagawa	高松市内	9	0.247-1.24	0.822±0.328
	34.20	134.63	Tokushima	鳴門市	7	0.195-0.859	0.417±0.226
	34.15	134.47	Tokushima	板東駅霊山寺	7	0.121-1.06	0.409±0.311
	34.07	134.55	Tokushima	徳島市内、眉山	8	0.090-0.971	0.473±0.282
	33.58	133.57	Koti	高知市五台山	13	0.068-0.864	0.341±0.257
	33.65	133.72	Koti	竜河洞	8	0.201-1.41	0.867±0.535
	33.45	133.58	Koti	朝倉高知大学	4	0.486-0.966	0.710±0.197
	33.50	133.58	Koti	高知城	8	0.385-0.976	0.730±0.225
	33.55	133.52	Koti	高知市桂浜	4	0.191-0.389	0.263±0.087
Kyusyu	32.75	130.33	Shimabara	島原町	4	1.53-4.00	2.69±1.31
	31.57	130.60	Sakurajima	桜島	5	2.43-7.39	4.48±1.85
	31.58	130.55	Kagoshima	鹿児島市内	25	4.52-18.1	7.97±3.01

In Fig. 1-2, data of low susceptibility ($< 1 \times 10^{-3}$ SI) is shown. In Fig. 2, averaged data is plotted on the map of Japan. Kansai and Shikoku districts where there is no Quaternary volcano, show the lowest susceptibility.

Soil with low susceptibility in Tohoku district was rather sandy. District named Tyubu2 containing Hokuriku and Tyukyo districts situated between Tyubu1/Kanto and Kansai results to include both high and low data.

In Muroran City situated in Hokkaido where industry factory is abundant, increased susceptibility by pollution was expected, but not detected. It was not increased compared with that in Otaru City or Sapporo City where industry factory is rare. The original high susceptibility of soil had not influenced by pollution to conceal the increasing of susceptibility. Whereas in Europe, original soil susceptibility is low, and additional pollutant definitely gives soil the influence of producing high susceptibility.

However, the author noticed the lower susceptibility was found in new park or agriculture farm, where cultivated recently (e.g. 7.29×10^{-3} SI at old temple in Kanto and 3.66×10^{-3} SI at park near the temple). It is worth to make grouping by surrounding condition and origin of soil even in high susceptibility regions.

For comparison, measured data in other countries, China(Tibet), Nepal, Thailand, Vietnam and France is shown in Table 4 and Fig. 3.

3. Conclusion

Soil susceptibility divides Japanese Islands into two. Volcanic region has high

Table 2 Mean of average in district.

Susx10^{-3}SI

		Point number	Range of average	Mean of average
Volcanic region	Hokkaido	7	5.91–10.40	7.22
	Tohoku	8	1.28–9.87	4.85
	Kanto	18	2.46–8.24	5.85
	Tyubu1	5	2.93–11.35	5.75
	Tyubu2	7	0.641–2.62	1.62
	Kyusyu	3	2.69–7.97	5.05
			Total average of mean	5.06x10^{-3}SI
Non-volcanic region	Kansai	5	0.186–0.555	0.341
	Shikoku	10	0.186–0.867	0.522
			Total average of mean	0.432x10^{-3}SI

Table 3 Rejected data (Susx10^{-3}SI)

Mean Sus	Point	
25. 4	Under metaic roof (23. 6–27. 2)	銭函駅前金属屋根雨だれ
28. 3	Ruin of railway station (10. 7–52. 7)	旧室蘭駅舎となり空き地
24. 2	Under cliff in Muroran City (16. 7–32. 0)	室蘭市祝津(消防署そばの崖下)
0. 27	Osorezan mountain (0. 077–0. 489)	下北郡恐山
1. 35	Kusatusirane mountain (0. 74–3. 58)	草津白根湯釜頂上
17. 6	Sakurajima Ash (15. 3–21. 8)	桜島灰あり

Table 4 Data in foreign countries.

Susx10^{-3}SI

Country	Data number	Range of data	Average±std
France	52	0.055–3.06	0.763±0.659
Thailand	4	0.336–2.89	1.73±1.21
Vietnam	100	0.003–5.54	0.720±0.734
Nepal	9	0.390–3.02	0.992±0.825
Tibet	18	0.178–6.98	2.19±2.25

Fig. 1-1 All of the soil data in Japan.

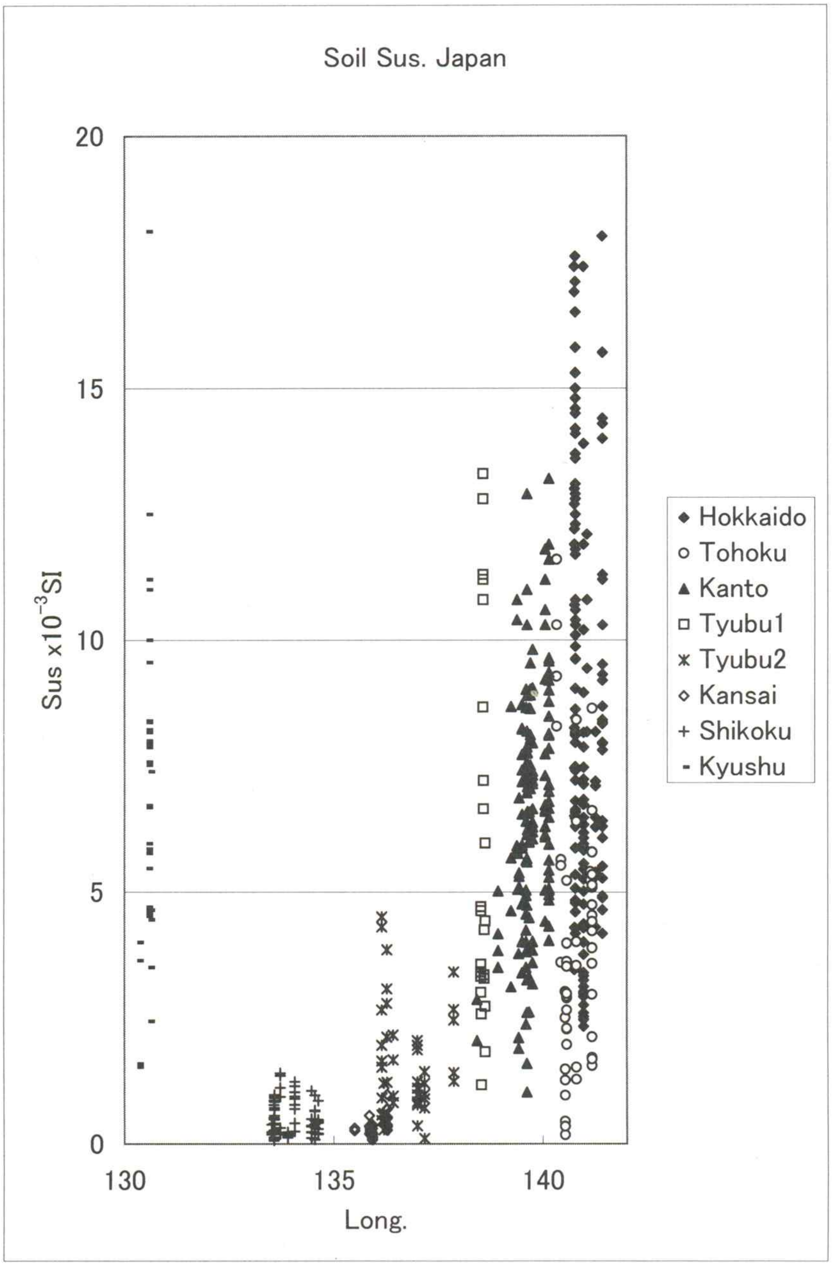


Fig. 1-2 Low soil data in Japan.

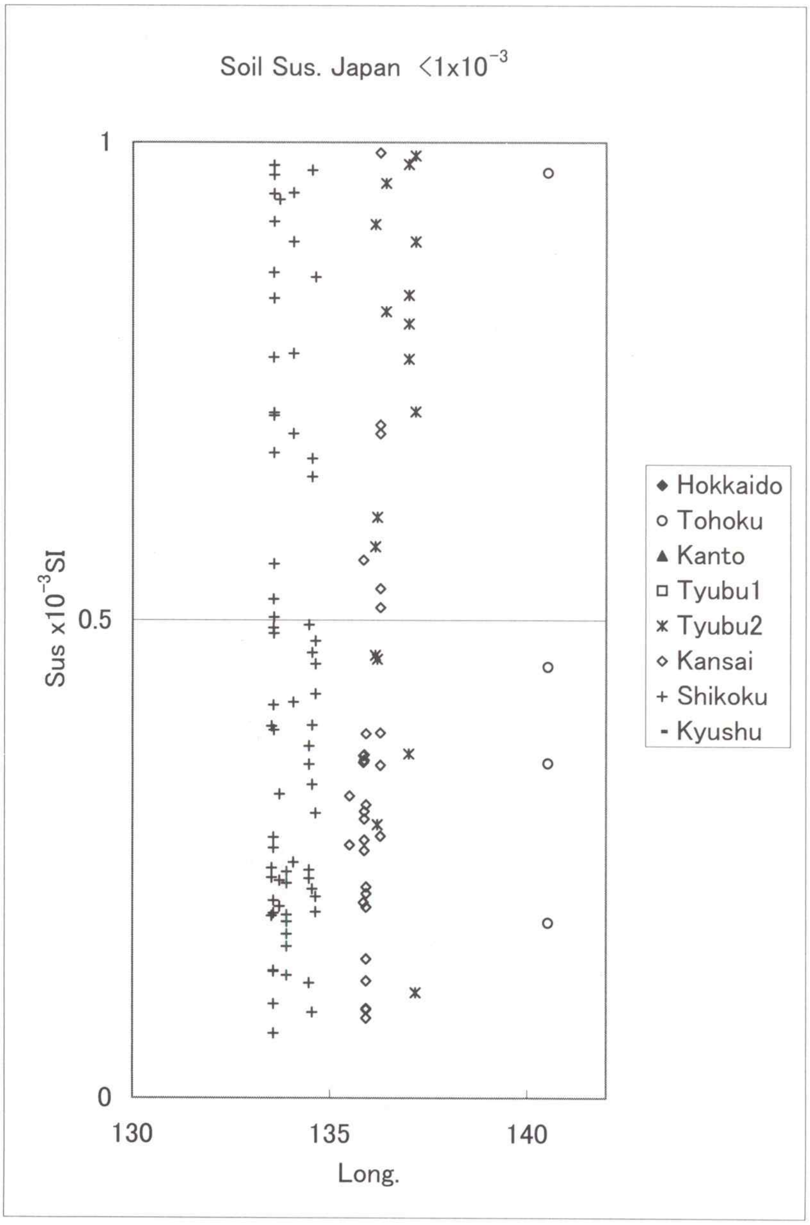


Fig. 2 Average of data at measuring points.

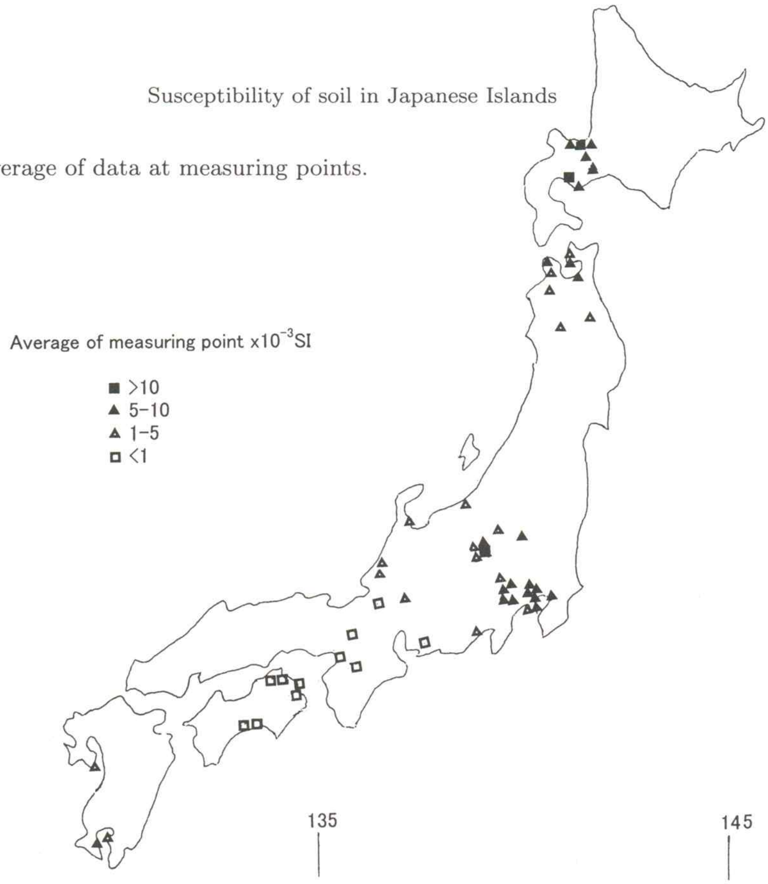
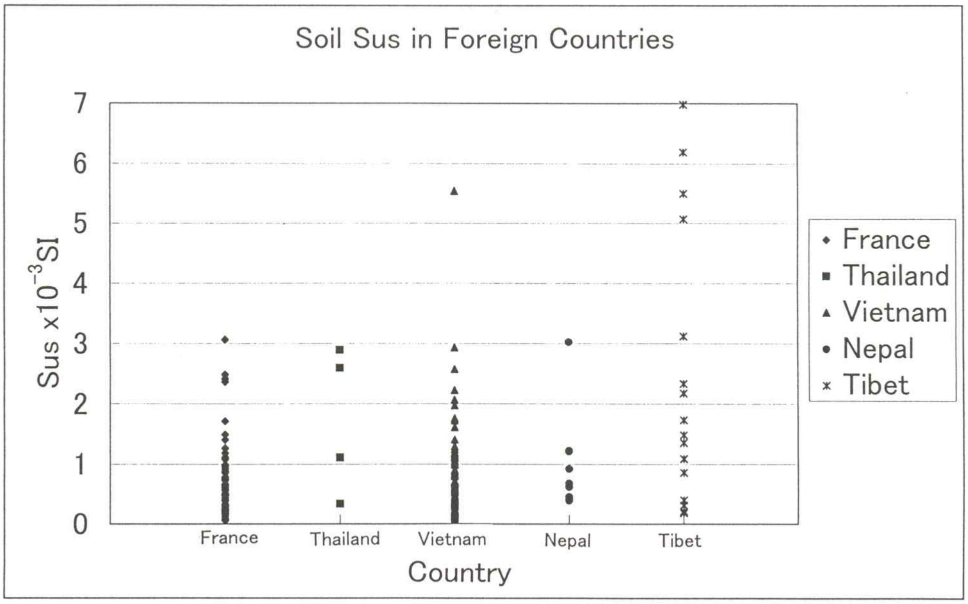


Fig. 3 Data in foreign countries.



susceptibility of the average 5.1x10^{-3} SI. Low susceptibility of averaged 4.3x10^{-4} SI was measured in districts of Kansai and Shikoku, where Quaternary volcano cannot be seen. Soil is constituted from mixture of in situ material with material carried from long distance, and expected to be uniform in wide range. In this respect, it is expected that the susceptibility of soil had been reflected by the geological history of districts, in case of Japan from this study, key term is existence of volcano in Quaternary.

To detect pollution of soil in Japan, it is better to study in non-volcanic region like Kansai and Shikoku.

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要旨

上野直子：日本列島の土壌帯磁率

帯磁率は第一義的には強磁性鉱物含有量に比例する。また、帯磁率は重金属との相関がある。強磁性鉱物の代表である磁鉄鉱は岩石や土壌や堆積物に含まれる他に、バクテリアによって作られたり化石燃料などが燃焼する時に作られるものもある。欧州地域は、もともと土壌の帯磁率が低いので、帯磁率の増加から汚染を検出するという研究が盛んである。帯磁率で日本の土壌の汚染度が議論できるのかを知る目的で日本中の大都市や郊外、農村、山岳地帯などを無作為に測定した。結果は日本では土壌帯磁率は第四紀の火山活動の影響が大きく欧州のような議論はむずかしいことがわかった。北海道、東北、関東などでは土壌帯磁率の平均は5.1x10^{-3} SIと高い。このために、多少の強磁性鉱物や重金属が附加さ

れても、もとの土壌の多様さの範囲に入ってしまい検出できないことがわかった。一方、関西地方や四国など第四紀に火山活動がない地域では平均 0.4x10^{-3}SI と低く、強磁性鉱物や重金属の附加による帯磁率の増加が検出できる可能性がある。日本で土壌の汚染度研究に帯磁率を用いるとすると、第四紀に火山活動がない地域で始めるべきである。しかし、高い帯磁率の地域でも新しい公園や畑など最近耕された場所は周りより低い傾向がみられるので、古い土と耕された土との比較により汚染を検出できる可能性がある。
キーワード：帯磁率、土壌、日本。