

Trace Elements Interaction in Grazing Cattle Products from Asbestos Mineralization, Andhra Pradesh, India

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ABSTRACT

In the present study an attempt has been made for biogeochemical studies involving elemental distribution and interactions in certain animal products viz., dung, urine and milk from Brahmanapalli asbestos mineralized area to determine their indicator characteristics and of their possible impact in applied environmental geoscience based on the observations made in ayurveda in the light of modern scientific developments. The samples of dung, urine, and milk from the matured grazing animals viz., cow, bullock, she-buffalo, he-buffalo, sheep and goat were collected systematically. Their physical properties like moisture/water content, organic matter and ash content are determined which shows wide variations. Trace element analysis of these samples was carried out for Ba, Sr, Cu, Pb, Zn, Ag, Mn, Ni, Co, Cr, Cd, Fe and Mg, and the parameter Coefficient of Apparent of Organic Binding (CAOB) is calculated for each element for dung of the animals. Wide variations are observed in the distribution of chemical elements in animal products viz., dung, urine and milk in both the seasons. It may be seen that the concentration of majority of elements for all animals is higher in winter than in summer. Certain elements are showing their presence and/or absence (not detected) in dung of the grazing animals on ash and/or dry weight bases, reflecting wide variations in their CAOB values. It is observed that Mg and Fe are the dominating elements in urine and milk of all animals in the study area. Mg is found to be in highest (275ppm) concentration in goat urine during winter than other animals. Mg is higher in goat milk during winter, in she-buffalo milk during summer.

Among all the elements Mg concentration is found to be high (250ppm) in goat milk during winter. The enrichment of Mg concentration in grazing animal products is may be due to the presence of asbestos mineral. Therefore cattle may ideally be used as tools for their possible application in mineral exploration. This study has given greater scope in biogeochemical orientation surveys, nutrition status of an area and environmental studies.

Key words:

Ayurveda; biogeochemistry; grazing cattle; dung; urine; milk; trace elements

1. INTRODUCTION

Biogeochemistry primarily deals with trace element imbalances arising due to excess or deficiency of mineral nutrients. These are generally reflected in plants and animals in a conspicuous manner in mining areas. Biogeochemical exploration deals with the trace element interactions in soil-plant system (Rose et al., 1979; kovalavskii, 1979) including animals (Brooks, 1983; Nicholas and Egan, 1975) to tackle various problems of applied environmental geochemistry (Thornton, 1983). The ancient scientific Sanskrit text Ayurveda provides some important clues which are significant in livestock biogeochemistry involving human health. In Ayurveda, for the health and longevity of the human life, the seven essential elements called dhatus are mentioned. The dhatus are gold, silver, iron,

copper, lead, zinc and tin (Prasad et al., 1989). It is well known that in modern literature (Thornton, 1983) among the dhatus, iron, copper, and zinc are the essential trace elements in plants, animals and human beings.

The ayurvedic texts prescribe panchagavyam (Guru Rao, 1935) which is a mixture of five cow products viz., dung, urine, milk, ghee and curd for treatment several diseases and disorders and it has lot of medicinal importance in promoting the longevity of human life. Further these ancient Sanskrit text also prescribe the consumption of cow dung and goat dung (Parthasaradhi Sarma, 1979) and external application of cow dung (Jolly, 1977) and of other cattle (Kantavallabhacharyulu, 1952) as finds application in domestic (Balfour, 1884), agricultural and industrial (ICAR, 1961) spheres. The ayurvedic texts (Venkata Sastry, 1959; Ambikadutta Shastri, 1979; Priyavrat Sharma, 1981; Pandey, 1986) pointed out that the urine of cow, goat, buffalo, sheep, horse, donkey, camel and elephant are prescribed for treatment of various physiological disorders of man. In recent studies, many workers (Kon, 1972; Campbell and Marshal, 1975; Lampert, 1975) widely describe different properties of milk and its products. Modern works on animal nutrition (Underwood, 1971; Maynard et al. 1979; McDonald et al. 1981; Bondi, 1987) thoroughly discussed about the significance of trace element interactions in animal products. Ayurveda states that the properties of the cattle products depend upon the ecological and environmental conditions their habitat and on their dietary components.

The significance of trace element interactions in cattle products comprising the dung, urine and milk have been studied earlier (Prasad et al., 1987, 1988, 1989, 1993, Soetan et al, 2010; Raghu, 1990, 2013) from mineralized areas. In view of the importance of livestock in relation to human health, biogeochemical characteristics of the grazing cattle are dealt

based on the observations made in ayurveda in the light of modern scientific developments in applied environmental geochemistry. In the present study an attempt has been made for biogeochemical studies involving elemental distribution and interactions in certain animal products viz., dung, urine and milk from Brahmaanapalli asbestos mineralized area to determine their indicator characteristics and of their possible impact in applied environmental geoscience.

2. STUDY AREA

Chrysotile asbestos deposit (Lat.14° 25' 15'': Long.78° 12') of Brahmaanapalli is located in Pulivendla mandal of Cuddapah District, Andhra Pradesh, and is included in the Survey of India toposheet No. 57J/3. The NW-SE trending Pulivendla asbestos belt forms a small segment in the S-W part of the Cuddapah Basin. This area is primarily consists of quartzites, shales, limestones and dolomites. Chrysotile asbestos belongs to the serpentine group of minerals, varieties of which are found in ultrabasic rock formations. The mineralized zone comprising yellow, green, black serpentine and talc. Chrysotile fibers are found as veins in serpentines, in serpentinized ultramafic rocks. Chrysotile asbestos is a hydrated magnesium silicate ($Mg_3Si_2O_5(OH)_4$). Earlier workers have carried out geological (Prasad and Prasanna, 1976), mineralogical (Vyasa Rao, 1980; Prasad and Prasanna, 1976), economical (Krishnan and Venkataram, 1942), and biogeochemical (Chandra Sekhar Reddy, 2013) aspects of this area.

3. SAMPLING AND ANALYTICAL METHODS

For the present study, the selected animals for biogeochemical characteristics are of not having any clinically detectable signs of disease or disorder. The samples of dung, urine, and milk from the matured grazing animals viz., cow, bullock, she-buffalo, he-

buffalo, sheep and goat were collected systematically from Brahmanapalli asbestos mining area, Cuddapah district, Andhra Pradesh. The dung samples of seven to ten animals for each species were collected in plastic bowls from each animal, directly at the time of excretion. To obtain a representative composite sample, all the dung of individual animals was mixed thoroughly. Samples of urine and milk of milch animals were collected separately in glass beakers. Further to obtain a representative composite sample, all the urine of individual animals and milk of individual animals was mixed thoroughly in polythene bottles. The samples were collected in summer and winter seasons. Moisture from the dung samples was eliminated by keeping them at 110°C in hot air oven for eight hours. Further, the organic matter from the moisture-free samples was eliminated at 500°C in a muffle furnace for three hours. Similarly, water content from urine and milk samples was eliminated by keeping them at 110°C in a hot air oven for eight hours. Further organic matter was estimated at 500°C in muffle furnace for four hours. In this study 0.5 gm of all biological samples were digested in 2M HCl as suggested by Brooks (1972). These samples were analyzed for trace elements viz., Ba, Sr, Cu, Pb, Zn, Ag, Mn, Ni, Co, Cr, Cd, Fe and Mg by means of atomic absorption spectrophotometer.

4. RESULTS AND DISCUSSIONS

4.1 Physical properties

Physical properties are determined for composite samples of dung, urine and milk of grazing cattle. These properties include

moisture/water content, organic matter, and ash content. The data is shown in Table 1. From the data the following observations are made.

In the study area, the ash content of dung of all animals is higher in winter than those in summer. Ash content (14.62%) of dung is recorded as high in she-buffalo and low (5.30%) in bullock during winter; and during summer it is recorded as high (12.78%) in sheep, and low (4.94%) in bullock. In both the seasons, low moisture content and high organic matter is found in goat dung, while highest amount of organic matter and ash content is noticed in goat urine. The moisture content of all animal dung is higher in winter than in summer (except in goat). In both seasons moisture content is found high in he-buffalo, where as it is recorded as low in goat dung during winter; and during summer it is low in she-buffalo dung. The organic matter of all animal dung is high during summer than in winter (except in sheep). In both seasons organic matter is recorded as high in goat dung while low in she-buffalo dung.

In both seasons, among all animal urine, water content in he-buffalo, ash and organic matter content in goat is recorded as high. Among the animal milk, goat shows highest ash content in both the seasons. Among the animal milk goat shows highest organic matter in both seasons. In the study area, wide variations in the physical properties of dung, urine and milk of all the animals in both the seasons may be attributed to their diet and conditions of their habitat (Raghu, 2013).

Table 1. Physical Properties of Dung, Urine and Milk of Grazing Cattle. (W= winter, S= summer)

Cattle	Season	Dung			Urine			Milk		
		Moisture %	Organic matter %	Ash %	Water content %	Organic matter %	Ash %	Water content %	Organic matter %	Ash %
Cow	W	45.92	46.10	7.98	93.70	2.60	3.15	80.20	17.70	2.10
	S	43.12	50.70	6.18	95.01	2.10	2.89	84.15	14.80	1.05

Bullock	W	42.47	52.23	5.30	95.91	1.95	2.14	-	-	-
	S	40.17	54.89	4.94	96.80	1.20	2.00	-	-	-
She-buffalo	W	46.10	39.28	14.62	94.05	1.72	4.23	79.25	18.83	1.92
	S	45.80	48.46	12.26	94.51	1.54	3.95	82.60	16.44	0.96
He-buffalo	W	49.14	42.64	8.22	98.59	1.14	0.27	-	-	-
	S	47.16	50.06	7.30	98.74	1.05	0.21	-	-	-
Sheep	W	29.15	59.62	13.75	92.79	2.26	4.65	74.45	22.80	2.75
	S	27.60	52.10	12.78	93.89	1.97	4.14	76.82	21.42	1.76
Goat	W	26.70	62.45	10.85	88.83	6.15	5.20	85.16	10.86	3.98
	S	28.30	63.44	8.26	89.26	5.70	5.04	86.30	11.70	2.00

4.2 Trace element analysis in Cattle Products

In this study, the samples of dung, urine and milk of the grazing animals of both the areas and seasons are analyzed for various trace elements viz., Ba, Sr, Cu, Pb, Zn, Ag, Mn, Ni, Co, Cr, Cd, Fe and Mg by means of atomic absorption spectrophotometer (Tables 2, 3, 4, and 5). The samples of dung are analyzed on ash weight and dry weight bases, urine and milk samples are analyzed on ash weight basis only. In the study area, it is observed that some elements are present on ash weight basis but the same elements are not detected on dry weight basis. Similarly some elements are present during winter in certain animals and the same elements are not detected in summer.

Dung

From the data (Tables 2,3), it is observed that among all the grazing animals, highest concentration of Mg (850ppm) is found in cow dung on ash weight basis in winter reflecting the composition of the mining/surrounding environment and the lowest concentration (35ppm) is found in goat dung on dry weight basis in winter. Pb is absent in bullock dung on dry weight basis during winter. During summer Pb is present in all animal dung on dry weight and ash weight basis (except in sheep). During winter, on ash weight basis Ag is absent in cow, bullock and she-buffalo dung; whereas it is present in dry weight. In all animals, Cd is not detected both on ash weight and dry weight bases in winter whereas this element is present

in summer. Co is not detected in goat dung on dry weight in both seasons. But it is present in all other animals on dry and ash weight basis in both seasons

During winter and summer in ash weight and dry weight basis, Ba is not detected in goat and he-buffalo, and this element is also not detected in cow on dry weight basis during both seasons. Sr is not detected in sheep and goat during winter and summer on dry weight basis. But it is present in ash weight basis during both seasons. This element is not detected in bullock and he-buffalo on dry weight basis in both seasons. Mn is present both on ash and dry weight basis in all animals during winter, while it is totally absent in he-buffalo during summer on ash and dry weight basis. Fe is present in all animals on dry and ash weight basis during both seasons. Ni is not detected in goat on dry and ash weight basis in both seasons while it is present in almost other animals.

Coefficient of Apparent of Organic Binding (CAOB)

In the present study, the parameter, Coefficient of Apparent of Organic Binding (CAOB) is calculated for each element for dung of the grazing animals for both the seasons (Tables 2, 3). It is the ratio of the concentration of an element on ash weight basis to that of the concentration of same element on dry weight basis. From the data (Tables 2, 3) it may be seen that certain elements are showing their presence and/or absence (not detected) in dung of the grazing animals on ash and/or dry weight

bases, reflecting wide variations in their CAOB values.

From the data (Tables 2, 3) it may be seen that there are wide variations for CAOB for all elements and for all animals. These variations may be attributed to the influence of organic matter in dry samples and degree of volatilization of different elements while

ashing. Greater concentration of trace elements occurs in the presence of organic matter (Hoffman and Fletcher, 1980). Ashing of biological materials results in partial or complete loss of volatile elements (Kovalevskii, 1979). The elements such as Pb, Zn, Cu, and Ag are volatile elements, while I, Co and Cr are classified as in volatile elements (Fletcher, 1981).

Table 2 Distribution of trace elements (ppm) in cattle dung from Brahmanapalli asbestos mining area during winter. (Concentration of the element on ash weight basis A, and dry weight basis D; CAOB = Co-efficient of Apparent Organic Binding).

Cattle Name		Ba	Sr	Cu	Pb	Zn	Ag	Mn	Ni	Co	Cr	Cd	Fe	Mg
Cow	A	20	10	75	25	20	ND	110	80	150	25	ND	90	850
	D	ND	12	20	10	10	2	38	20	75	ND	ND	26	275
	CAOB	-	0.83	3.75	2.5	2.00	0	2.89	4.00	2.00	-	-	3.46	3.09
Bullock	A	10	ND	20	17	12	ND	130	10	50	25	ND	40	360
	D	6	ND	25	ND	ND	5	95	ND	30	22	ND	32	100
	CAOB	1.66	-	0.80	-	-	0	1.36	-	1.66	1.13	-	1.25	3.60
She-buffalo	A	ND	2	30	25	20	ND	96	70	200	40	ND	60	660
	D	5	ND	21	20	15	2	82	30	88	ND	ND	20	110
	CAOB	0	-	1.42	1.25	1.33	0	1.17	2.33	2.27	-	-	3.00	6.00
He-buffalo	A	ND	ND	ND	16	15	10	16	115	30	25	ND	12	275
	D	ND	ND	ND	12	12	ND	19	50	30	18	ND	20	59
	CAOB	-	-	-	1.33	1.25	-	0.84	2.30	1.00	1.38	-	0.60	4.66
Sheep	A	8	6	32	28	ND	3	28	110	225	72	ND	120	185
	D	ND	ND	24	18	ND	2	18	25	55	36	ND	42	80
	CAOB	-	-	1.33	1.55	-	1.50	1.55	4.40	4.09	2.00	-	2.85	2.31
Goat	A	14	3	12	19	25	2	32	ND	75	12	ND	60	75
	D	ND	ND	16	25	21	3	46	ND	ND	10	ND	19	35
	CAOB	-	-	0.75	0.76	1.19	0.66	0.69	-	-	1.20	-	3.15	2.1

Table 3 Distribution of trace elements (ppm) in cattle dung from Brahmanapalli asbestos mining area during summer. (Concentration of the element on ash weight basis A, and dry weight basis D; CAOB = Co-efficient of Apparent Organic Binding).

Cattle Name		Ba	Sr	Cu	Pb	Zn	Ag	Mn	Ni	Co	Cr	Cd	Fe	Mg
Cow	A	12	20	40	13	11	10	80	60	50	10	6	70	ND
	D	ND	15	36	15	10	8	70	40	33	ND	4	65	ND
	CAOB	-	1.33	1.11	0.86	1.10	1.25	1.14	1.50	1.51	-	1.50	1.07	-
Bullock	A	8	2	15	26	14	ND	110	6	30	20	2	110	275
	D	ND	ND	12	40	16	3	74	ND	19	22	3	84	90
	CAOB	-	-	1.25	0.65	0.87	-	1.48	-	1.57	0.90	0.66	1.30	3.05
She-buffalo	A	10	4	18	15	13	ND	40	25	49	28	3	20	420
	D	8	4	12	19	9	5	18	3	10	ND	4	10	85
	CAOB	1.25	1.00	1.50	0.78	1.44	-	2.22	12.50	4.90	-	0.75	2.00	4.94
He-buffalo	A	ND	2	5	3	10	5	ND	100	28	19	2	24	315
	D	ND	4	19	15	5	ND	ND	90	26	13	5	10	55
	CAOB	-	0.50	0.26	0.20	2.00	-	-	1.11	1.07	1.46	0.40	2.40	5.72

Sheep	A	3	4	4	ND	ND	3	10	100	50	20	4	82	80
	D	ND	ND	10	ND	ND	6	18	25	60	18	3	70	90
	CAOB	-	-	0.40	-	-	0.50	0.55	4.00	0.83	1.11	1.33	1.17	0.88
Goat	A	50	15	50	18	18	5	14	ND	30	8	8	7	200
	D	ND	ND	38	29	13	4	20	ND	ND	5	5	4	90
	CAOB	-	-	1.31	0.62	1.38	1.25	2.80	-	-	1.60	1.60	1.75	2.22

Urine

From the data (Table 4), it is observed that Mg and Fe are the dominating elements in urine of all animals in the study area. Mg is found to be in highest (275ppm) concentration in goat urine during winter than other animals in asbestos mining area. Fe is found to be high (210ppm) in goat urine during winter. Ag is consistently absent in all animal urine during both seasons but during winter it is present only in cow and goat. In all animal urine Mn is present in winter but absent in summer. In both the seasons, Cd is consistently absent in all animal urine. During summer, Ba and Sr are completely absent in all animals urine, while these are present in bullock, he-buffalo and she-buffalo during winter. Ba and Sr are also not detected in cow, sheep and goat in both seasons.

Sex difference in urine

From the data (Table 4), it has been observed that, there are wide variations in the elemental concentration of the urine of the male and female animal species. Concentration of Cu and Mn in winter, Cu, Pb, Ni, Cr, Fe, and Mg

in summer is recorded as high in cow urine than that of bullock.

Sr, Cu, Pb, Fe and Mg during winter; Pb, Ag, Mn and Co summer are in higher concentration in she-buffalo than in he-buffalo. The elements Pb, Fe and Mg are higher concentration in she-buffalo than in he-buffalo in both seasons.

Milk

In the study area generally, all elements show higher concentration in winter season than in summer in all grazing animal milk. It is observed that Mg and Fe are the dominating elements in milk of all animals in the study area. Mg is higher in goat milk during winter, in she-buffalo milk during summer. Among all the elements Mg concentration is found to be high (250ppm) in goat milk during winter. Fe is found to be in high (80ppm) concentration in cow milk during winter. Mn is present in winter but absent in summer. Ba and Sr are absent in both the seasons except Ba in case of goat, Sr in case of cow and sheep during winter.

Table 4 Distribution of trace elements (ppm) on ash weight basis in cattle urine from Brahmanapalli asbestos mining area

Cattle	Season	Ba	Sr	Cu	Pb	Zn	Ag	Mn	Ni	Co	Cr	Cd	Fe	Mg
Cow	W	ND	ND	16	20	8	6	10	12	8	ND	ND	90	175
	S	ND	ND	20	15	ND	ND	ND	40	15	25	ND	75	120
Bullock	W	20	10	12	32	14	ND	5	75	10	17	ND	120	190
	S	ND	ND	10	14	7	ND	ND	24	16	12	ND	60	85
She-buffalo	W	12	16	17	32	6	ND	3	31	20	14	ND	175	240
	S	ND	ND	5	15	20	ND	ND	24	22	10	ND	78	165
He-buffalo	W	15	5	10	15	16	ND	8	75	34	26	ND	48	167
	S	ND	ND	ND	6	5	ND	ND	24	40	14	ND	36	115
Sheep	W	ND	ND	20	ND	7	ND	2	47	22	31	ND	200	230
	S	ND	ND	10	ND	2	ND	ND	29	26	27	ND	122	210
Goat	W	ND	ND	ND	10	ND	10	25	28	56	40	ND	210	275
	S	ND	ND	28	ND	ND	ND	ND	19	49	29	ND	140	224

Table 5 Distribution of trace elements (ppm) on ash weight basis in cattle milk from Brahmanapalle asbestos mining area

Cattle	Season	Ba	Sr	Cu	Pb	Zn	Ag	Mn	Ni	Co	Cr	Cd	Fe	Mg
Cow	W	ND	5	18	13	9	10	37	ND	16	18	ND	80	110
	S	ND	ND	10	10	6	ND	ND	10	ND	11	ND	30	83
She- buffalo	W	ND	ND	35	16	12	ND	45	ND	27	32	ND	60	240
	S	ND	ND	8	20	14	ND	ND	27	ND	10	ND	50	136
Sheep	W	ND	2	17	ND	10	ND	28	16	42	15	ND	75	154
	S	ND	ND	ND	ND	6	ND	ND	28	15	ND	ND	26	116
Goat	W	5	ND	42	24	17	ND	25	30	38	39	ND	54	250
	S	ND	ND	16	18	12	ND	ND	19	26	14	12	31	105

4.3 Seasonal Variations

In the present study wide variations are observed in the distribution of chemical elements in animal products viz., dung (Tables 2, 3), urine (Table 4), and milk (Table 5) in both the seasons. Earlier workers also showed marked seasonal variations in the uptake of various heavy metals (Robinson, 1943; Barshad, 1951; Chebaevskaya, 1960) including copper and Zinc (Warren and Howatson, 1947) in particularly leaves. Such seasonal variations are also observed in trace element content of cattle products and this is attributed to change in botanical composition of the herbage which results in trace element disorders in animals (Reuter, 1975).

From the data (Tables 2, 3, 4, 5) it may be seen that the concentration of majority of elements for all animals is higher in winter than in summer. It is also reflected by higher values of CAOBS in winter. From this, it seems that the excess of metal ingested by the animals during winter do not seem to participate in organic binding but are safely excreted as inorganic components into the dung, urine and secreted into milk.

4.4 Elemental sequences

Different workers (Plant and Risewell, 1983; Basolo and Pearson, 1958) have suggested different orders or sequences of the trace elements under different physico-chemical or biological conditions, based on elemental

analysis. These types of sequences are found to give valuable information regarding the elemental behavior in biological and geological materials. In the present work, the elemental sequences of the animal products based on absolute concentration, are arranged in decreasing order and the following observations are made

Dung

During winter, Mg occupies first position in most of animal dung on both ash and dry weight bases. Both on ash and dry weight bases, cow and she-buffalo show the sequence of Mg>Co>Mn in winter. During summer, on dry weight basis, the dung of bullock and sheep show the sequence of Mg>Fe.

The dung of cow and bullock during winter show the sequence of Mg>Fe>Cu>Pb on ash weight; Mg>Cu on dry weight; and during summer, Fe>Zn on dry weight basis.

During winter on both ash weight and dry weight Mg>Co in she-buffalo; and in he-buffalo Mg>Ni. During summer, on ash weight basis, Mg>Co in she-buffalo and in he-buffalo the sequence is Mg>Ni, and Mg>Pb in she-buffalo, and Ni>Mg in he-buffalo on dry weight during summer.

Urine

In both the seasons, Mg occupies position in all animal urine. In asbestos mining area, in both

the seasons, Mg>Fe is observed in all animal urine.

Milk

The milk of animals in asbestos mining area show the sequence of Mg>Fe during winter; and in summer the sequence is Mg>Mn>Zn in the case of she buffalo and sheep.

5. SUMMARY AND CONCLUSIONS

In the study area, wide variations in the physical properties of dung, urine and milk of all the grazing animals in both the seasons may be attributed to their diet and conditions of their habitat (Raghu, 2013). Some elements are present on ash weight basis but the same elements are not detected on dry weight basis. Similarly some elements are present during winter in certain animals and the same element is not detected in summer. In the present study wide variations are observed in the distribution of chemical elements in animal products viz., dung, urine and milk in both the seasons. It may be seen that the concentration of majority of elements for all animals is higher in winter than in summer. It is also reflected by higher values of CAOB in winter. In Bramhanapalli asbestos mining area, the concentration of magnesium in the dung, urine and milk in almost all grazing animals is remarkably higher. The enrichment of Mg concentration in grazing animal products is may be due to the presence of asbestos mineral (Magnesium hydrous silicate) and their surrounding habitat. These asbestos is responsible for the release of Mg predominantly in large amounts and the biogeochemical province (Vinogradov, 1964) is influenced by local enrichment of metals due to the existence of ore bodies and their associated dispersion halos. Further the biogeochemical data may be considered for the monitoring of the pollution levels of mining environment. Further, in the study area all grazing cattle products consisting of high concentration of Mg and therefore cattle may

ideally are used as tools for their possible application in asbestos mineral exploration. This study has given greater scope on the grazing cattle-soil relationship in the mining/mineralized areas and their significance in biogeochemical orientation surveys, nutrition status of an area and environmental studies.

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