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Trace metal distribution in groundwater and surface soils of Fazilka district, SW Punjab, India.

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Regional hydraulic gradient towards southwest (SW) in Punjab, India turned the Fazilka district into a wet desert with concerns of poor soil and water quality. Selected surface soils and groundwater from bore wells and tube wells up to 450 ft depth were examined for trace metal distribution. Manganese content in the studied soil was the highest and U the least in the order Mn>Zn>Cr>>Ni>Cu>As>Co>Se>Th>U (Table 1). Contrarily, U content in groundwater were greater than other trace metals at all depths in the order U>Zn>Mn>Cr>Cu>Se>As>Ni>Co>Th. A circum-neutral to alkaline nature (pH 7.06-8.44) with Na^{+}-HCO_3^{-} water type characterizes the groundwater. Exceptionally high dissolved solids (171-3180 mg/L) and salinity (200-2500 mg/L) were measured. The intermediate depth (i.e., 100-250 ft) is enriched in trace metals except shallow depth enrichment of Zn and Ni, while groundwater >350 ft contains very less trace metals. Uranium contents are beyond WHO permissible limit of 30 µg/L in ~90% of studied groundwater, whereas western part of the district nearer to Sutlej river contains U <30 µg/L. A contrasting behavior of trace metals and U, i.e., high dissolved U, but poor soil contents and the opposite for other trace metals, is indicative of alkalinity favored U mobilization from aquifer sediments, whereas the prevailed grochemical condition might not be favorable for other trace metal release, rather remained intact with soil constituents like Fe-Al oxides and organic matters. The increased trace metal contents at intermediate depth might have caused by surface infiltration processes.

Table 1 Trace metal distribution (µg/L) at different depths and surface soils along Fazilka district, SW Punjab, India.

Trace metals → Depth(ft)↓	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Th	U
<60	6.5-58.2	4.9-134.2	0.1-0.7	1.2-8.2	0.9-42.7	45.7-237.6	2.5-21.0	5.2-15.7	0.01-0.1	0.8-203.7
100-250	9.7-117.9	6.5-219.7	0.2-0.6	1.2-2.4	5.7-66.5	18.5-82.0	2.4-31.0	12.1-27.9	0.02-0.2	26.7-282.9
350-450	4.5-11.9	7.9-15.7	0.06-0.2	1.2-1.8	6.5-21.6	22.9-60.1	4.3-10.8	8.7-13.4	0.02-0.05	55.4-153.8
Surface soil	233.5-345.2	828.1-1834.8	24.6-54.0	90.7-158.6	65.4-133.7	365.5-425.6	67.7-109.6	5.8-25.3	6.2-25.3	8.6-16.5