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**Research Paper**

# Trace Element Chemistry of the Major Lakes in and around Nainital City, Kumaun Lesser Himalaya, Uttarakhand

**[1,2,1]Nirmit Sah; [3]D. S. Parihar; [2]Rajeev Upadhyay and [4]Rashi Miglani**

*1-Department of Geology, Swargiya Chandra Singh Shahi Govt. PG College, SSJ University, Kapkote, Uttarakhand (India)-263642*
*2-Center of Advanced Study, Department of Geology, D.S.B. Campus, Kumaun University, Nainital, Uttarakhand (India)-263001*
*3-Department of Geography, D.S.B. Campus, Kumaun University, Nainital, Uttarakhand (India)- 263001*
*4-Department of Forensic Science, DSB Campus, Kumaun University, Nainital, Uttarakhand, India-263002*

**ARTICLE DETAILS**

***Corresponding Author:***
Nimrit Sah

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**ABSTRACT**

Lakes of Kumaun Lesser Himalaya, India are important water bodies for sustaining the life. These lakes are also the center of tourist's attraction. The lakes have a tectonic origin and are characterized by Dolomites, Limestones, Shales, Silicates and Volcanic Rocks and provide many ecosystem services. The present study was carried with the help of ICP-MS to determine the heavy metals (lithium, beryllium, sodium, magnesium, aluminium, potassium, calcium, titanium, vanadium, manganese, iron, cobalt, gallium, arsenic, selenium, rubidium, strontium, silver, cesium, barium, lutecium, gold, mercury, thallium, lead and uranium) pollution of the Nainital, Bhimtal and Naukuchiatal Lakes. The water chemistry indicates above permissible limit of Hg in all the three studied lakes as 5.825 ug/L, 2.03 ug/L and 2.44 ug/L respectively. The other heavy metals having high concentration levels are Be, Al, Ag and Se. The study suggests that these trace metals concentrations are attributed by anthropogenic as well as geologic factors. The elevated levels of heavy metals; specifically, mercury, beryllium, and selenium, identified in Nainital Lake represent a significant concern for both public health and environmental integrity. The presence of mercury poses substantial risks to human health, particularly through neurological complications and associated health hazards.

## 1. Introduction

The survival of life on earth depends on water. To support human's daily water needs, nature has provided a great variety of freshwater bodies, including rivers, lakes, and wetlands. Ninety percent of the world's surface freshwater is found in lakes (Mishra et al. 2011). Due to stagnant water, lakes lack the ability to purify themselves they are considerably more susceptible to water contamination as compared to the other water bodies (Khadka et al. 2012). Any artificial obstruction, such as change in nutrients dynamics have severe impacts on the physicochemical characteristics of water, which may negatively impact the variety of flora and fauna in and around the lake (Chakrapani, 2002; Kumar et al., 2019). Indian Himalayas has unique topography provoking the formation of several natural lakes. The lake in the Nainital district of Kumaun Lesser Himalaya, India includes- Nainital Lake, Bhimtal Lake, Naukuchiatal Lake, and Sattal Lake- which is the main sources of freshwater. These lakes constitute popular tourist destination as well (Purushothaman et al., 2012; Sah et al., 2024).

Water demands to meet the needs of the rapidly expanding population in the Nainital district (26.67% population decadal growth rate in 1991-2001 based on Census, 2001) and an increase in tourism-related waste have significantly exacerbated the water quality in the lakes (Sharma, 2014). These contaminants infiltrate the food chain and pose a serious threat to human health (Gautam et al., 2013). In this area, some studies have been undertaken to understand the ecological health of

[1]*Corresponding Author can be contacted at: nirmitsah@kunainital.ac.in*
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the lakes (Ali et al., 1999; Jain et al., 2007; Singh et al., 2008; Gupta et al., 2010). Lakes in this area have been investigated for tectonics and structure (Valdiya, 1980; Valdiya, 1988) accumulation of sediments (Das et al., 1995), water balancing (Kumar et al. 1988) and paleo-climatic circumstances (Chakrapani, 2002; Kotlia et al., 2000) However, no study has been conducted for a comparative assessment of the water quality in the major lakes of Nainital district in such a large number of trace element analyses.

Therefore, the present study was aimed to determine the eco-toxic profiles of heavy metal ions of three different lakes of Nainital district.

## 2. Material and Methods

### *2.1 Study Area*

Uttarakhand is largely a mountainous terrain region made up of thirteen districts with a predominance of hilly terrain at an altitude fluctuation of 200m to 7,800m ASL. In terms of significance for the environment and as a tourist destination, the three lakes in the district- Nainital, Bhimtal and Naukuchiatal are the most significant bodies of water. Their respective parameters are given in Table-1. District Nainital is located approximately between 80º 14' and 78º 80' East longitude and 29º 00' and 29º 05' North latitude. All lakes are small to medium in size with the Bhimtal Lake as the largest one, covering 72 ha area (Joshi et al., 2016). Lake Naukuchiatal is the deepest, with a maximum of 40.8 m depth. The proposed study area comprises the three virgin Himalayan lakes located in the Nainital District namely Nainital, Bhimtal and Naukuchiatal (Fig. 1). With an elevation of 2084m above mean sea level, the Nainital district is a popular hill area in the Kumaun region of the lesser Himalayas in the state of Uttarakhand.

### *2.2 Sample Collection and Processing*

Water samples were collected from the surface of lakes located in Nainital districts namely Nainital, Bhimtal and Naukuchiatal shown in (Fig. 2). Collection of water samples were done during the month of October i.e., post monsoon and later on were transferred to a 15ml propylene tubes prior to the analysis. The samples were analyzed by Inductively Coupled Plasma Mass Spectrometry (Agilent technologies, 7700x series, ICP MS Mass Hunter, Version 4.1) to identify concentrations of elements in the sample. The samples were digested using the Microwave Reaction System (MWRS). The MWRS is effective and efficient in rapid sample preparation. The microwave was set with a minimum power of 700W and a maximum of 1200 W, the internal temperature was maintained at 200°C to 250°C. The microwave program ramping total time was 1 hour 33 minutes. The vessels were cooled to the room temperature, then the digestates were prepared in a fume hood and diluted up to 10mL and transferred in a 15mL centrifuge tube. The samples were centrifuged at 4000 rpm for 10 min and analyzed by ICP-MS. Multi element calibration standard was used for preparation of calibration standards. Metal free ultrapure grade water was used for preparation of calibration standards as well as dilution of the water samples.

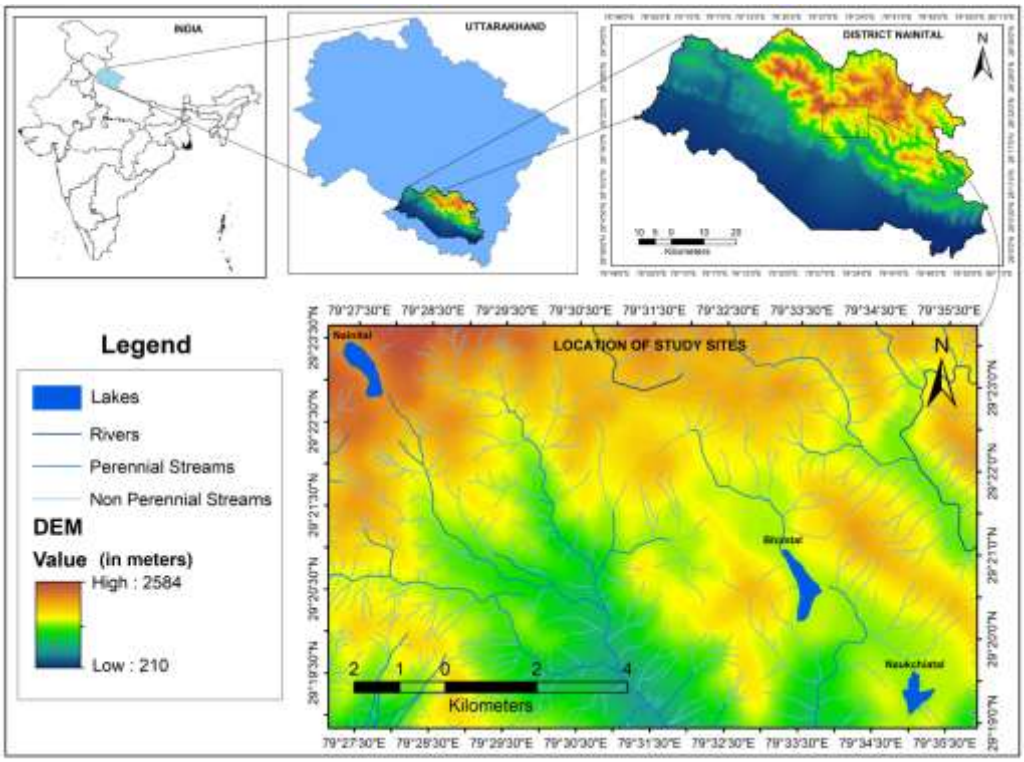


**Fig. 1** Location map of the Study Sites, i.e. Nainital, Bhimtal and Naukuchiatal Lake, Kumaun Division, Uttarakhand (*based on DEM, field surveying by using GPS)*.

**Table-1:** Parameters of the three lakes of the study area (*Sharma et al., 1982; Gupta et al., 1989; Khana et al., 1985*).

| SNo | Parameters | Nainital Lake | Bhimtal Lake | Naukuchiatal Lake |
|---|---|---|---|---|
| 1 | Altitude(m) | 1937 | 1331 | 1320 |
| 2 | Longitude | 79$^0$28'E | 79$^0$32'E | 79$^0$35'E |
| 3 | Latitude | 29$^0$24'N | 29$^0$20'N | 29$^0$19'N |
| 4 | Length(m) | 1432 | 1974 | 1050 |
| 5 | Width(m) | 423 | 457 | 675 |
| 6 | Max deepness(m) | 27.3 | 25.8 | 42.25 |
| 7 | Mean deepness(m) | 16.2 | 11.5 | 21.89 |
| 8 | Surface area(km$^2$) | 0.48 | 0.85 | 0.375 |
| 9 | Catchment Area(m) | 3.96 | 11.4 | 3.25 |
| 10 | Shoreline | 3630 | 4023 | 3600 |
| 11 | Annual rainfall(mm) | 2300 | 1711 | NA |
| 12 | Max air temp($^0$C) | 24.6 | 33 | NA |
| 13 | Min air temp ($^0$C) | 0.5 | 1.5 | NA |
| 14 | Max water temp ($^0$C) | 25 | 28 | NA |
| 15 | Min water temp($^0$C) | 10 | 14 | NA |
| 16 | Volume of water(m$^3$) | 5907500 | 4245700 | 7055000 |

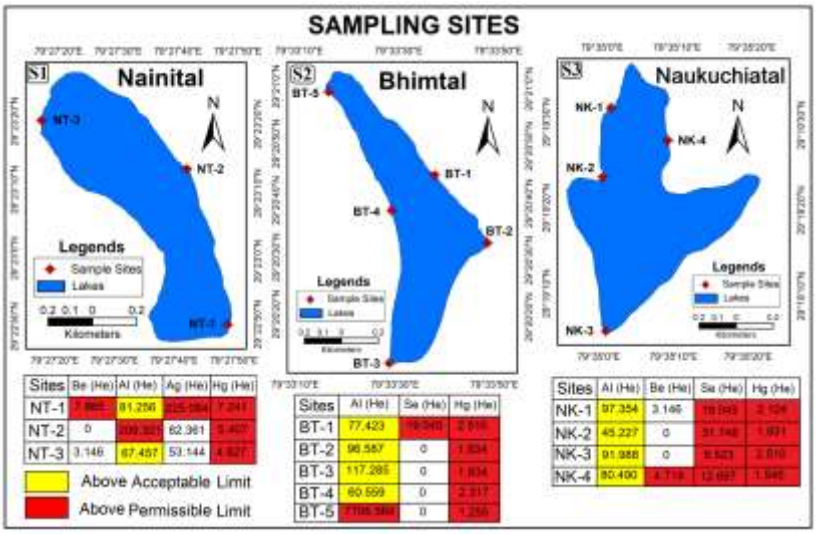


**Fig. 2** Sample locations on study sites (*based on field surveying by using GPS*).

*2.3 Heavy Metal Testing and Analysis*

This research paper presents the findings of a trace metal analysis conducted on 12 water samples collected from three lakes using the ICPMS-7700 series instrument manufactured by Agilent Technologies, USA shown in (Fig. 3). The lakes samples were selected strategically as they represent convergence points for all drainages, allowing for comprehensive analysis of potential contamination sources. The study aims to assess the levels of trace metals present in these water bodies, thereby providing valuable insights into the environmental quality and potential risks associated with contamination. The instrument was operated in helium mode and argon gas was used as plasma gas and carrier gas. The metals were studied while Rhodium metal was used as an internal standard. The composite water samples were taken in airtight acid-washed plastic containers to prevent unpredictably changing characteristics of water. All samples were kept in sampling kits with a 4°C temperature (APHA, 1992). The water samples were then taken to the lab for an experimental investigation. The standard permissible and acceptable limit of water is given in Table-2.

**Fig. 3** ICPMS-7700 Series, Agilent Technology, USA.

**Table-2**: Bureau of Indian Standard (BIS, 2012) guidelines for trace elements in water.

| S. N. | Element (mg/l) | AL (ug/l) | PL (ug/l) | Sample Sites | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NT-1 | NT-2 | NT-3 | BT-1 | BT-2 | BT-4 | BT-5 | BT-6 | NK-1 | NK-2 | NK-3 | NK-4 |
| 1 | Li | NA | NA | 29.239 | 23.388 | 11.694 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2 | Be | 4 | NA | 7.865 | ND | 3.146 | ND | ND | ND | 1.573 | 1.573 | 3.146 | ND | ND | 4.719 |
| 3 | Na | 200000 | NA | 10419.37 | 13740.92 | 17011.59 | 4616.995 | 4889.643 | 4910.169 | 4727.949 | 8720.445 | 4537.99 | 5824.56 | 4198.68 | 4149.26 |
| 4 | Mg | 30000 | 100000 | 45425.23 | 44231.47 | 59776.88 | 7742.562 | 7774.581 | 8139.855 | 8167.254 | 8494.639 | 8154.62 | 6688.05 | 6898.05 | 6917.45 |
| 5 | Al | 30 | 200 | 81.256 | 209.321 | 67.457 | 77.423 | 96.587 | 117.285 | 60.559 | 7706.564 | 97.354 | 45.227 | 91.988 | 80.49 |
| 6 | K | 100000 | 500000 | 485.262 | 701.231 | 3362.661 | ND | ND | ND | ND | 277.802 | ND | ND | ND | ND |
| 7 | Ca | 75000 | 200000 | 5848.924 | 6360.732 | 7225.991 | 2583.202 | 2741.62 | 2778.185 | 2985.328 | 3034.089 | 2875.68 | 2363.9 | 2887.87 | 3143.76 |
| 8 | Ti | 0.1 | 0.1 | ND | ND | ND | ND | ND | 10255.08 | 35176.81 | 45392.37 | ND | ND | ND | ND |
| 9 | V | 21 | 21 | 0.636 | 0.091 | ND | 2.633 | 2.542 | 1.513 | 2.33 | 4.902 | 0.908 | 1.453 | 0.696 | 0.938 |
| 10 | Mn | 100 | 300 | ND | ND | ND | ND | ND | ND | ND | 62.429 | ND | ND | ND | ND |
| 11 | Fe | 300 | NR | 32.251 | 36.902 | 38.472 | 45.462 | 47.18 | 45.521 | 47.003 | 266.186 | 57.668 | 46.321 | 52.068 | 45.462 |
| 12 | Co | NA | NA | 0.377 | 0.04 | ND | 0.04 | ND | 0.377 | 0.148 | 8.773 | 0.606 | 0.067 | 0.445 | 0.121 |
| 13 | Ga | NA | NA | 0.294 | 0.391 | 0.785 | 0.589 | 0.294 | 0.491 | 0.294 | 2.158 | 0.392 | 0.098 | 0.098 | 0.785 |
| 14 | As | 10 | 50 | 3.159 | 2.218 | 1.613 | 0.672 | 0.269 | 0.403 | 0.538 | 3.294 | 1.412 | 1.143 | ND | 1.21 |
| 15 | Se | 10 | NR | 6.348 | 9.523 | 3.174 | 19.045 | ND | ND | ND | ND | 19.045 | 31.746 | 9.523 | 12.697 |
| 16 | Rb | NA | NA | 5.192 | 3.166 | 7.788 | ND | ND | ND | ND | 11.271 | ND | 0.507 | ND | ND |
| 17 | Sr | NA | NA | 433.633 | 439.773 | 684.594 | 81.862 | 85.021 | 83.298 | 79.803 | 96.513 | 78.318 | 51.986 | 55.385 | 59.311 |
| 18 | Rh | NA | NA | 110348 | 106619 | 109545 | 104441 | 106764 | 95463 | 95966 | 96097 | 106002 | 102139 | 105977 | 102766 |
| 19 | Ag | 100 | NR | 225.084 | 82.361 | 53.144 | 2.473 | 2.815 | 2.302 | 1.67 | 2.275 | 5.445 | 5.471 | 3.88 | 2.683 |
| 20 | Cs | NA | NA | 1.991 | 1.645 | 2.38 | 0.433 | 0.108 | 0.173 | ND | 0.628 | 0.454 | 0.216 | 0.238 | 0.173 |
| 21 | Ba | 700 | NR | 176.355 | 186.14 | 161.853 | 149.59 | 167.631 | 156.782 | 127.897 | 218.916 | 170.457 | 199.11 | 197.696 | 157.135 |
| 22 | Lu | NA | NA | 0.061 | 0.114 | 0.045 | 0.174 | 0.144 | 0.189 | 0.151 | 0.212 | 0.159 | 0.106 | 0.167 | 0.151 |
| 23 | Au | NA | NA | 342.882 | 196.514 | 149.672 | 13.322 | 12.926 | 10.94 | 11.424 | 10.018 | 15.417 | 13.76 | 13.903 | 13.277 |
| 24 | Hg | 1 | NR | 7.241 | 5.407 | 4.827 | 2.51 | 1.834 | 1.834 | 2.317 | 1.255 | 2.124 | 1.931 | 2.51 | 1.545 |
| 25 | Tl | 0.002 | 0.005 | 7.214 | 4.719 | 3.401 | 0.627 | 0.572 | 0.53 | 0.565 | 0.634 | 0.718 | 0.572 | 0.634 | 0.425 |
| 26 | Pb | 10 | NR | 6.783 | 4.57 | 3.725 | 2.686 | 2.871 | 2.559 | 2.564 | 8.419 | 2.86 | 2.839 | 2.903 | 2.729 |
| 27 | U | NA | NA | 0.181 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

*NT- Nainital Lake, BT- Bhimtal Lake, NK- Naukuchiatal Lake AL- Acceptable Limit, PL- Permissible Limit, NA- Not Applicable, NR- No Relaxation, ND- Not Detected,*

*2.4 Data analysis*

Variations in the heavy metal concentration among the lakes were assessed by Analysis of Variance (ANOVA) using IBM SPSS version 23. Means and pair wise comparisons of significance were recorded for significant factors.

## 3. Results

The mean of the heavy metal analysis and ANOVA results (F and P value) of selected lakes is presented in Table-3:

*3.1 Non-Carcinogenic Elements*

**Beryllium:** Be is reported from all the lake sites having a concentration range from 0 to 7.865 ug/L. The trace element is found to cross the permissible limit of 4 ug/L in the following lake sites named as NT-1 (7.865 ug/L) and NK-4 (4.719 ug/L) stated in Table-1.

**Aluminium:** This trace element is reported from every studied lake site and has a concentration range from 45.227 ug/L to 7706 ug/L. It is clearly seen that Al concentration has crossed its acceptable limit of 30ug/L in every sample site and has reported to exceed its permissible limit in the sites named as NT-2 and BT-6, in Table-1 i.e. in the lakes of Nainital and Bhimtal respectively.

**Rubidium:** The maximum concentration is found to be 7.788 ug/L from the Nainital Lake.

**Silver:** Ag is reported to cross its acceptable and its permissible limit from the site of Nainital lake namely NT-1 having a concentration of 225.084 ug/L.

**Table-3**: The mean of the heavy metal analysis and ANOVA results of Nainital, Bhimtal and Naukuchiatal Lake.

| Metal | Nainital Lake Mean ± SD | Bhimtal Lake Mean ± SD | Naukuchiatal Lake Mean ± SD | F | P |
|---|---|---|---|---|---|
| **Li** | 20.952603±7.35873396 | Not detected | Not detected | 37.417 | 0.000 |
| **Be** | 2.752704494±3.716792546 | 0.62919± 0.861553 | 1.966217 ± 2.359461 | .855 | .454 |
| **Na** | 13793.5809± 2694.89056 | 5573.04± 1763.575 | 4677.621± 783.9048 | 28.759 | 0.000 |
| **Mg** | 50785.70131±7327.596405 | 8063.778± 311.8298 | 7164.539± 668.1732 | 158.194 | 0.000 |
| **Al** | 113.080276± 65.088915 | 1611.684± 23.43913 | 78.76485± 23.43913 | .761 | .492 |
| **K** | 1411.284978±1325.264271 | 55.56035± 124.2367 | Not detected | 4.956 | 0.032 |
| **Ca** | 6494.8004± 569.253 | 2824.485± 185.0893 | 2817.802± 326.8715 | 130.674 | 0.000 |
| **Ti** | 0.000± 0.000 | 18164.85± 20935.81 | 0.000± 0.000 | 2.895 | .102 |
| **V** | 0.1815659± 0.3056412 | 2.784082± 1.263952 | 0.998646± 0.321202 | 11.565 | 0.003 |
| **Mn** | 4.4848796± 8.9697591 | 12.48587± 27.91926 | 0.000± 0.000 | .540 | .599 |
| **Fe** | 36.15375± 2.6995677 | 90.27034± 98.34303 | 50.3799± 5.675277 | .928 | .427 |
| **Co** | 0.104424± 0.182911 | 1.867844± 3.863039 | 0.309925± 0.25851 | .714 | .513 |
| **Ga** | 0.367913± 0.292965 | 0.765259± 0.789162 | 0.343386± 0.325395 | .844 | .458 |
| **As** | 2.453702± 0.682342 | 1.035203± 1.271577 | 0.941098± 0.637713 | 3.260 | .081 |
| **Se** | 4.761366± 4.097931 | 3.809093± 8.51739 | 18.2527± 9.827947 | 4.334 | 0.044 |
| **Rb** | 4.432416± 2.680939 | 2.254208± 5.040563 | 0.000± 0.000 | 1.503 | .269 |
| **Sr** | 525.2998± 117.4914 | 85.29942± 6.554972 | 61.25± 11.76593 | 67.116 | 0.000 |
| **Rh** | 107738.5± 2719.695 | 99746.3± 5413.748 | 104220.8± 2058.221 | 4.742 | 0.036 |
| **Ag** | 97.57339± 87.69376 | 2.306891± 0.415771 | 4.369881± 1.348464 | 5.343 | .026 |
| **Cs** | 1.839342± 0.447671 | 0.268327± 0.25632 | 0.270506± 0.125545 | 37.481 | .000 |
| **Ba** | 161.2047± 28.93057 | 164.163± 33.88223 | 181.0996± 20.71521 | .561 | .587 |
| **Lu** | 0.0549± 0.0468834 | 0.174165± 0.027826 | 0.14577± 0.027826 | 13.842 | .001 |
| **Au** | 197.9382± 103.9452 | 11.72579± 1.379622 | 14.08946± 0.924859 | 14.643 | .001 |
| **Hg** | 5.527255± 1.188686 | 1.950167± 0.489461 | 2.027389± 0.401975 | 30.597 | .000 |
| **Tl** | 4.424376± 2.0959053 | 0.585459± 0.044356 | 0.587196± 0.123559 | 80.150 | .000 |
| **Pb** | 4.635552± 1.507084 | 3.819696± 2.574238 | 2.832693± 0.074119 | .979 | .409 |
| **U** | 0.045128± 0.090257 | Not detected | Not detected | 1.154 | .354 |

- *Indicates the level of significance is 0.05*

*3.2 Carcinogenic Elements*

**Gallium, Arsenic and Strontium**: The following trace elements namely Ga, As and Sr has been reported from the lake sample sites and has a maximum concentration of 2.158 ug/L from the Bhimtal Lake, 3.294 ug/L from the Bhimtal Lake, and 684.494 ug/L from the Nainital Lake respectively.

**Selenium:** Se concentration is found to be awfully close to its acceptable limit from the sites named as NT-4 and NK-3. However, Naukuchiatal Lake has Se above its acceptable limit (10 ug/L) and in a state of no relaxation as per BIS regulation 2012 having a mean concentration of 18.25 ug/L. There is also a site named as BT-1 from the Bhimtal Lake having Se concentration of 19.045 ug/L and reported to be above its acceptable limit.

**Cesium, Lutecium and Lead:** Cs**,** Lu and Pb are all to be present in trace amounts in the lake sites. However, none have exceeded their acceptable and permissible limit in the study area.

**Mercury:** The level of Hg has been seen to cross the acceptable limit (1 ug/L) and there is no relaxation above it in the three lakes of the study area situated in the Nainital district. The mean concentration of Hg ranges from 1.42 to 5.52 ug/L. Nainital Lake has shown the max concentration of 7.241 ug/L.

**Uranium:** U concentration is reported from the Nainital lake site namely NT-1 having 0.181 ug/L.

## 4. Discussion

ANOVA table reveal that the value of Li, Na, Mg, K, Ca, V, Se, Sr, Rh, Ag, Cs, Lu, Au, Hg and Ti are significantly different among the three lakes. The geological map of the area (Fig. 4) shows that the Nainital Lake is surrounded by the Krol group of rocks comprising of dolomites associated with limestone and shale (Awasthi, 1970).

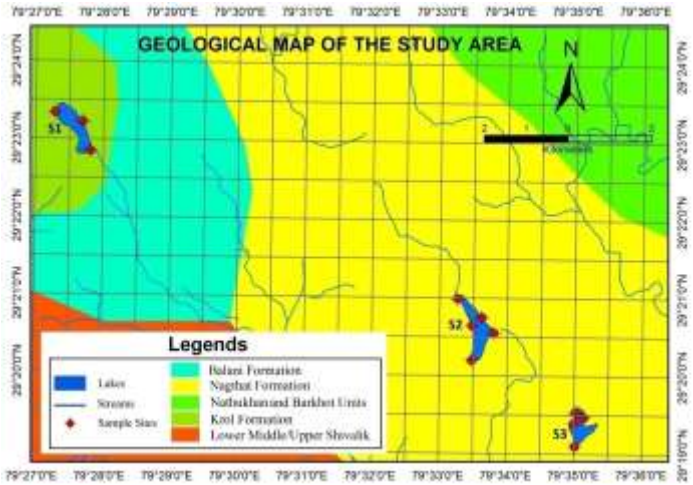


**Fig. 4** Geological map of the study area (Valdiya, 1980; Valdiya, 1988; Awasthi, 1970).

On the other hand, Bhimtal and Naukuchiatal Lake lies in the Nagthat formation which consists of thickly bedded quartz arenite associated with the penecontemporaneous mafic lava flows (Pant et al, 1999). The source of aluminum in the lake waters is due to the weathering of rocks containing feldspar and aluminum containing rocks. Selenium has its major occurrence in the mafic igneous rocks (Malisa et al., 2001). Volcanic igneous rocks surround the Bhimtal and Naukuchiatal region (Chakrapani, 2002). Therefore, it is assumed that the main cause of selenium contamination in the area is the leaching from the basic volcanic rocks. Low grade uranium mineralization is associated with phosphatic sediments and carbonaceous shale around the Krol-Tal contact in the region of inner Krol belt (Sinha et al., 2016). Mercury is emitted by natural sources and as well as from the volcanoes, geothermal springs, geologic deposit and the oceans. Human related sources primarily include coal combustion, waste incineration, industrial uses and mining (USGS, 2018). Mercury in the Nainital region may be mostly due to the anthropogenic sources through the sewage waste water. But in Naukuchiatal and Bhimtal region, mercury deposits appear related with the geological and anthropogenic sources. The source of silver in Nainital which is found above the impermissible limit might be related with the limestone rock of Krol-Tal formation.

## 5. Conclusion

Therefore, from the analysis of trace element concentration sites NT-1 and NK-4 are prone to high concentration of beryllium. Silver is found to be above permissible limit in lake site namely NT-1 and selenium have higher concentration above permissible limit in the entire Naukuchiatal lake. Mercury is found to be present in all the entire lakes of the study area with values crossing their permissible limit in every sample sites. Data comparisons with WHO drinking water criteria reveal that the majority of lake water sites are unfit for human consumption. In conclusion, the elevated levels of heavy metals, specifically mercury, beryllium, and selenium, identified in Nainital Lake represent a significant concern for both public health and environmental integrity. The presence of mercury poses substantial risks to human health, particularly through neurological complications and associated health hazards. This finding is particularly alarming given that all three lakes under study serve as primary sources of drinking water, indicating a direct threat to the well-being of local communities.

Furthermore, from an ecological standpoint, the heightened concentration of beryllium in the lake water has the potential to detrimentally impact aquatic ecosystems. Beryllium contamination may lead to a reduction in biodiversity within the lake, thus disrupting the delicate balance of the aquatic food chain. Such ecological disturbances can have far-reaching consequences, ultimately affecting the overall health and sustainability of the aquatic environment. In light of these findings, urgent action is warranted to address the sources of heavy metal contamination in Nainital Lake and mitigate the associated risks to both human health and ecological stability. Implementing effective pollution control measures, enhancing water treatment protocols, and raising awareness about the dangers of heavy metal exposure are crucial steps in safeguarding the health of both communities and ecosystems reliant on these vital water resources. Additionally, ongoing monitoring and research efforts are essential for assessing the efficacy of remediation strategies and ensuring the long-term resilience of Nainital Lake and its surrounding environment. For both residents and visitors, the lake is of the utmost importance and value, making its preservation essential. It has become polluted and is on the verge of losing its original traits as a result of growing urbanisation. Therefore, careful water management and ongoing monitoring of the lake's water are necessary.

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**Author Contribution:** Conceptualizing and design involved during this work were done by all the authors. **Nirmit Sah** prepared material and methods, experiment design, software, data validation, original draft; **D. S. Parihar** prepared the figures, material and methods and mapping; **Rajeev Upadhyay** involved in supervision, editing and reviewing of the MS. **Rashi Miglani:** Editing and reviewing. The final manuscript was read and approved by all the authors.

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**Declarations**

**Conflict of Interest:** The author(s) declares no conflict of interest.

**Ethics Approval Statement:** There is no any experimental work done on human and animals.

**Data Availability Statement:** The datasets analyzed during the current study are available from the corresponding author on reasonable request.

**Author Agreement:** All authors approve the submission of the manuscript.

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