U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

# Digital National Uranium Resource Evaluation (NURE) geochemistry for the Pacific Northwest: a contribution to the Interior Columbia River Basin Ecosystem Management Project

by

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Open File Report 95-686

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## Introduction

This report provides background information on the regional geochemical data provided by the U.S. Geological Survey to the U.S. Forest Service and Bureau of Land Management Interior Columbia Basin Ecosystem Management Project (ICBEMP). The data are available via the internet as described below. This report is one in a series of digital maps, data files, and reports generated by the U.S. Geological Survey to provide geologic process and mineral resource information to the Interior Columbia Basin Ecosystem Management Project. The various digital maps and data files are being used in a geographic information system (GIS)-based ecosystem assessment including an analysis of diverse questions relating to past, present, and future conditions within the general area of the Columbia River Basin east of the Cascade Mountains.

### The Interior Columbia Basin Ecosystem Management Project

In January of 1994, the Chief of the U.S. Forest Service (USFS) and the Director of the Bureau of Land Management (BLM) initiated what was then called the Eastside Ecosystem Management Project to, "develop a scientifically sound and ecosystem-based strategy for management of eastside forests." The project was further directed to, "develop an ecosystem management framework and assessment for land administered by the Forest Service and the Bureau of Land Management on those lands east of the Cascade crest in Washington and Oregon and within the interior Columbia River Basin." The driving force behind the project was the need to develop a strategy for dealing with anadromous fish habitat and watershed conservation in eastern Oregon and Washington. Subsequently, when it became clear that similar strategies were needed for anadromous fish in the remainder of the Columbia River Basin (particularly in Idaho and Montana), the project was extended to include all of the Columbia River drainage basin in the United States, east of the Cascade Mountains divide plus the remainder of southeastern Oregon which is not within the drainage basin (fig. 1). At that time, the project was renamed the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

The ICBEMP is producing scientific assessments of current and historic landscape conditions; of aquatic and terrestrial habitat, species distributions, and populations; and of economic and social conditions. The project is also producing scientific assessments of the potential future conditions and possible tradeoffs likely to result from a range of possible disturbances and management practices on public lands in the basin. Although scientific assessments are being conducted for the entire basin, management decisions that are based on the assessments will apply to public lands (USFS and BLM) only.

The goal of the ICBEMP management strategy is to provide management tools which can be used to sustain or restore ecosystem integrity and to promote products and services desired by society over the long term. The management strategy is intended to provide tools to balance ecosystem conditions, resource uses, and competing values of ecosystem users. The intent of the project is to understand the ramifications of past, present, and future management practices and man-made or natural disturbances both in the area subject to the management practice or disturbance and in areas which may be remote, in time and/or space.

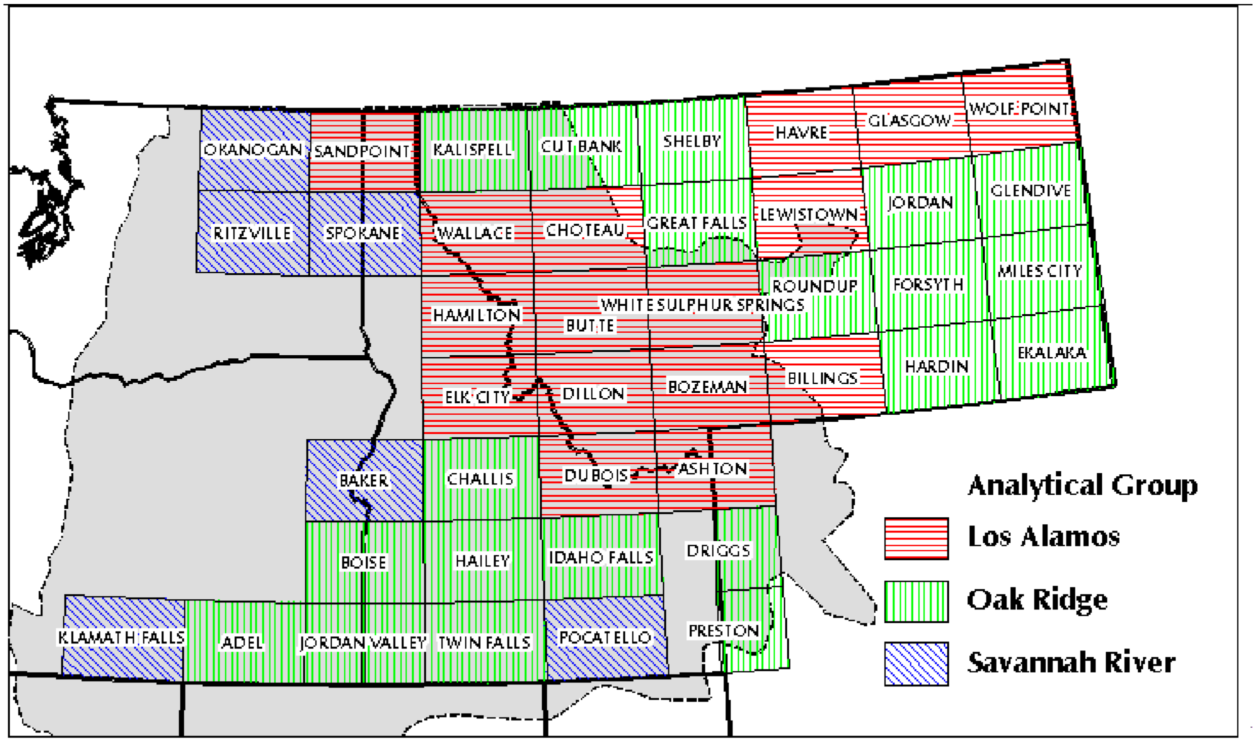


Figure 1: Index map showing analytical groups and the extent of the Landscape Characterization Area of the Science Integration Team of the Interior Columbia Basin Ecosystem Management Project (gray). The 1° by 2° quadrangles (line patterns) used for grouping the NURE geochemistry are shown.

The project is organized around two teams, the Science Integration Team and the Environmental Impact Statement Team, with overlapping membership. Both teams are further sub-divided into staff areas (sub-teams of subject experts) including: landscape ecology, aquatic/riparian, terrestrial, forest policy and economics, and social sciences. Many staff scientists work on both the Science Integration Team and the Environmental Impact Statement Team.

Specific objectives of the project are:

- To conduct a <u>broad scientific assessment of the resources</u> within the interior Columbia River Basin to characterize and assess landscape, ecosystem, social, and economic processes and functions and describe probable outcomes of various management practices and trends.
- To develop an <u>ecosystem management framework</u> that includes principles and processes which may be used in a National Environmental Protection Act (NEPA) process to develop management direction for federal agencies at all levels within the basin.
- To write an <u>Eastside Environmental Impact Statement</u> (EIS) proposing a broad array of

alternative strategies for an area that encompasses ten national forests and portions of four BLM districts in eastern Washington and Oregon (fig. 1).

- To write an Upper Columbia River Basin EIS with a similar array of alternative strategies for an area that encompasses lands administered by the BLM and USFS in Idaho, western Montana, Wyoming, Utah, and Nevada within the Columbia River Basin (fig. 1).
- To conduct a scientific evaluation of issues and alternatives identified through the NEPA scoping process for the Eastside EIS.

The ICBEMP is an intense, short term project to develop several regionally-consistent, land-management alternatives. These alternatives, derived from basin-wide analyses of highly generalized data, will form a framework for land-management decisions at the local level. This framework will be modified as better data and understanding of the basin are developed. Under the project, a flexible, basin-wide, digital database will be developed that will evolve and improve as higher resolution data become available. All data are being collected in a GIS-compatible format for digital display, analysis, and distribution. Information on the availability of all digital data sets, paper maps, and other reports generated by the ICBEMP can be obtained from:

Interior Columbia Basin Ecosystem Management Project
ATTN: Cindy Dean
112 E. Poplar Street
Walla Walla, WA 99362
(509) 522-4030

or from:

Bureau of Land Management
ATTN: Becky Gravenmeier, OR99.2
Oregon - Washington State Office
P.O. Box 2965
Portland, OR 97208
(503) 952-6273

**Project extent and scale**

The scope and extent of the project area varies as a function of the objective. The scientific assessment, for example, includes all lands, not just those that are federally managed. This objective is focused on the Columbia River Basin but is not strictly limited to the actual drainage basin boundaries. Moreover, some scientific assessment subject sub-teams, by necessity, have extended their work beyond the limits of the formal project because factors such as wildfires and wildlife migration are not limited by drainage divides or political boundaries. Most subject sub-team project areas are restricted to the Landscape Characterization boundary developed by the Landscape Ecology group (fig. 1). The scientific assessment is primarily based on information suitable for compilation at a scale of 1:1,000,000.

**U.S. Geological Survey involvement**

In June, 1994, the USGS was asked to provide estimates on the value of undiscovered mineral resources for the Columbia Basin. In the course of discussions with members of various  sub-teams from both project teams, it became apparent that additional earth science information was also highly relevant to the assessment of historic, current, and future ecological, economic, and social systems, and that the USGS could provide this information in a digital format.  Within the ICBEMP's tight schedule (7 months from the USGS start date until the information had to be available to the rest of the Science Integration Team), the USGS was able to provide basin-wide, integrated, digital information about bedrock lithology, rock chemistry, potential animal habitat, regional geochemistry, volcanic and earthquake hazards, and mineral resources.  The bedrock lithology is summarized in Johnson and Raines (1995).  The bedrock chemistry information is summarized in Raines, Johnson, Frost, and Zientek (1996).  Potential animal habitat information is summarized in Frost, Raines, Almquist, and Johnson (1996), and regional  geochemistry is summarized in Raines and Smith (1996).  Digital hazards information was derived from Algermissen, et al (1990) and Hoblitt, Miller, and Scott (1987).  Mineral resources information is summarized in Box, et al (1996); Bookstrom, Zientek, et al (1996); Zientek, Bookstrom, Box, and Johnson (1996); and Bookstrom, Raines, and Johnson (1996).

Information on the regional geochemistry portion of the study is covered by this report.   The regional geochemistry is primarily the stream-sediment samples analyzed by the NURE program.  Where stream-sediment samples are not available, soil samples are sometimes available and these were used to help expand the coverage.  For regional assessments focusing on gross areal differences, soil samples are sufficiently similar to stream-sediment samples to allow their use, particularly in semi-arid environments.  Considerably more information was identified as potentially useful to the ICBEMP, but integrated digital products could not be provided for the entire study area within the time frame of the assessment.

## Data Source and Editing

The data provided on internet for this report is derived primarily from the National Uranium Resource Evaluation (NURE) of the Department of Energy for the states of Oregon, Washington, Idaho, and Montana.  These data were acquired from the U.S. Geological Survey, Branch of Geochemistry, and edited and reformatted for use in Arc/Info GIS.  These data were acquired and edited before the establishment of the U.S. Geological Survey National Geochemical Data Base; however the original data with error corrections  and important additional documentation are now available on CDROM (Hoffman, Gunnels, and McNeal, 1991).

The NURE program was established for an evaluation of the uranium resources of the United States in the 1970's.  The program collected extensive and varied geochemical data.  The data provides the most comprehensive,  publicly available stream sediment geochemistry of large portions of the United States.  Data were collected and catalogued by standard $1^\circ$ by $2^\circ$ quadrangles as summarized in Figure 1.

A major consideration for use of the data is that the geochemical analytical methods were not consistent in the four different NURE laboratories (Savannah River, Oak Ridge, Lawrence Livermore, or Los Alamos).  Thus there are differences between quadrangles due to differences in analytical method.  For the Hailey quadrangle, the USGS analyzed archived splits of the NURE samples as well as some new samples, and the results were reported in Malcolm and Smith (1992). These USGS analyses were used here, and NURE analytical data were used for the other quadrangles in the Northwestern U.S. The total data are useful for regional evaluations which considers gross geochemical differences. Due to differences between laboratories and sampling methods, subtle differences can be interpreted with care within a single $1^{\circ}$ by $2^{\circ}$ quadrangle. As part of the initial editing of the data in a spreadsheet format, important information about the data were tabulated and other data were eliminated from this data base. These tabulated files are listed in Table 1 and are available on internet with this report.

Table 1: Summary spreadsheet files and metadata files available on internet.

| | |
|---|---|
| analmeth.wq1 | Analytical methods by quadrangle in Quattro Pro |
| of95-686.pdf | Metadata for these export files in Adobe Acrobat PDF format. |

**Spreadsheet Editing**

When the data were received, there were many inconsistencies among quadrangles and some errors that required correction in order to prepare a regional data set. In most quadrangles, NURE data were reported as parts per billion (ppb). However in some quadrangles, the analytical results for major elements (Al, Na, K, Mg, Ca, and Fe) were reported as parts per ten thousand. The major elements are here reported in percent and all other elements in parts per million (ppm). NURE preceded the name of the element with the label "CON". For example the element silver was labeled CONAG. The labels for the elements are changed here to match the more commonly used chemical abbreviations, for example silver is Ag. Longitudes are expressed as negative values, designating the western hemisphere, and both latitudes and longitudes are expressed in decimal degrees. In addition there were many data fields that were eliminated from the data base because the editor (C. Smith) decided they were unimportant.

NURE samples were analyzed by several different methods (see file analmeth.wq1). Not all samples were analyzed by each method nor were there redundant analyses for an individual element. A value of zero was entered to indicate that the element was not analyzed at the site. Sites lacking most of the analyses were eliminated from this data set. Usually less than 1% of the sample sites were dropped because of incomplete analyses. For an explanation of the meaning of the abbreviations used in the spreadsheet tables see Appendix A of this report or Hoffman and others (1991). Averett (1984), which is available from the U.S. Geological Survey Library in Denver, Colorado, is the original source of this information.

NURE assigned each sample in a quadrangle a unique number. The first two digits of the NURE number do not change within a quadrangle. To provide more convenient map identification, the first two digits of the NURE number are replaced with two alpha characters that identify the quadrangle. For example, if NURE's unique identifier of a sample site in the Adel quadrangle was 1123406, then this sample is listed here as AD23406.

For an element that was below the limit of detection (censored) in a sample, the value is reported here as a negative number. This is a modification from the original data made to assist with statistical analyses of the data by the editor (C. Smith). The percent of samples for each element not censored help with interpretation of statistics, for example; if less than 1% of the values of silver were uncensored, little confidence should be placed in interpreting the silver distribution in the quadrangle.

**GIS Data and Final Edit**

The analytical data were then divided into three analytical groups, reformatted, and imported as point coverages into the Arc/Info GIS. The data were grouped by the laboratory at which most of the samples from a site were analyzed. This grouping facilitates analysis and display of the data in the GIS because each group has consistent analytical methods. The elements included in each group are listed in Table 2. The point coverages were located by latitude and longitude and then projected to the map projection used for the ICBEMP. The projection information is included with the coverages. The original latitude and longitudes are included in the data set; so if there are questions about the accuracy of the projection, the locations can be recalculated. The spatial distribution of the analytical groups is shown in Figure 1. From the Arc/Info point coverages DOS-compatible dBase (.dbf) files were prepared of the data. These files include the location information and can be used by many programs. As described above, a final stage of editing was done using the display functions of Arc/Info. The point coverages were then exported in the Arc/Info export format. The GIS export files and dBase files of the data are listed in Tables 3 and 4.

Table 2: Elements determined in each analytical group. The three groups are Los Alamos National Laboratory (lanl), Oak Ridge National Laboratory (oak), and Savannah River National Laboratory (sr). The analytical method used for each element is listed in file analmeth.wq1 available on internet for this report. The lanl, oak, and sr data sets contain 22876, 21209, and 4693 sample sites, respectively.

| | |
|---|---|
| lanl | Ag, Al, As, Au, Ba, Be, Bi, Ca, Cd, Ce, Cl, Co, Cr, Cs, Cu, Dy, Eu, Fe, Hf, K, La, Li, Lu, Mg, Mn, Na, Nb, Ni, Pb, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Th, Ti, U, V, W, Yb, Zn, Zr |
| oak | Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Eu, Fe, Hf, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Th, Ti, U, V, W, Y, Yb, Zn, Zr |
| sr | Ag, Al, As, Ba, Be, Ca, Ce, Co, Cr, Cu, Dy, Eu, Fe, Hf, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Sc, Se, Sm, Sn, Sr, Th, Ti, U, V, W, Y, Yb, Zn |

Table 3: GIS files available on internet for this report. These files are in the ARC export format.

| | |
|---|---|
| lanl.e00 | Arc/Info export file of Los Alamos samples. |
| sr.e00 | Arc/Info export file of Savannah River samples. |
| oak.e00 | Arc/Info export file of Oak Ridge samples. |

Table 4: dBase files available on internet for this report. These files are in the DOS dBase format. The lanl and oak data bases had to be broken into 4 separate files to make them manageable as dBase files.

| | |
|---|---|
| lanl(1,2,3,4).dbf | dBase format of lanl point attribute table. |
| oak(1,2,3,4).dbf | dBase format of oak point attribute table. |
| sr.dbf | dBase format of sr point attribute table. |

After the editing and reformatting described above, there were still errors of various types in the data. These errors include misplaced decimal points and analytical errors. In an attempt to locate and correct errors of misplaced decimal places, the following procedure was used.

Plots were made for all elements using the Arc/Info class quantile command with 5 intervals. This command inspects the histogram for the element from a specified data set and defines 5 intervals with an equal number of sites in each interval. It is a useful way to quickly display the data in order to identity blocks of inconsistent data. The Los Alamos data set was used generally to define the intervals. This set of intervals was then applied to display all three data sets. The resulting display clearly differentiates those quadrangles with an order of magnitude difference from their neighbors. Those quadrangles that were a multiple of 10 different than their neighbors were adjusted by multiplication or division by an appropriate multiple of 10. Adjustments by multiples of 10 that were made to the data are summarized in Table 5 by element.

In this process, there were often observed differences between quadrangles that were not related to misplaced decimal points, that is multiplying the values in the different quadrangle by 2 or 3 would make it fit better with its neighbors. These differences are noted in Table 5 as fractionally different. It is not clear whether this difference is due to analytical or sampling method and/or geologic differences or some human error. No changes or corrections were made in these data set for these differences.

A third common problem is apparently due to differences in how batches of samples were processed in the laboratory (Stan Church, personal communication, 1993). In the NURE laboratories, samples were processed within a 2-degree quadrangle by samples within a 15 by 15 minute block. This is seen as significantly different values in 15 by 15 minute blocks in a quadrangle. There was no correction made for this problem.

Three quadrangles are prominent in that problems of the types described above often occurred. These quadrangles are Sandpoint (Idaho), Challis (Idaho), and Klamath Falls (Oregon). Inspection of the sample-type data field (samptyp, which is defined in Appendix A) for the Klamath Falls, Idaho Falls, and most of the Challis quadrangle samples showed that these fields contained invalid NURE sample-type codes. Elimination of the sites with invalid sample-type codes eliminated these problems, and the remaining samples fit with their neighbors. Consequently no data were retained for Klamath Falls and Idaho Falls; presumably data may be available in Hoffman and others (1991) for these quadrangles. Particular care should be used with the remaining sites in Challis and Sandpoint data sets. Additionally the sample types for the Choteau quadrangle were blank in the Arc data for unknown reasons. From inspection of Hoffman and others (1991), it was decided that the valid stream-sediment samples (mostly sample types 12 and some 15, which are defined in Appendix A) were included. Therefore, these samples were not eliminated and the sample type (samptyp) is denoted here as "12 or 15".

Table 5: Summary of adjustments and problems with elemental values. The only change made was to multiple or divide by a multiple of 10. This adjustment made the data in close agreement with the data in the surrounding quadrangles. Fractionally high or low, indicates that the data are different by some value less than 10, typically near 2 or 3. The comment, 15 minute blocks, refers to the problem of differences between analytical batches in a quadrangle. Poor data indicates an element with only a few analyses and no distinct patten in the data.

| Element | Problems and Adjustments |
|---|---|
| Ag | Oak Ridge data group except Challis - divided by 10, Los Alamos data group - divided by 10 |
| Al | Jordan Valley - 15 minute blocks, Boise - fractionally high |
| As | Challis - fractionally low |
| Au | Poor data |
| B | Jordan Valley - fractionally high |
| Ba | Challis - fractionally low |
| Ca | Sandpoint - multiplied by 10 |
| Cd | Poor data |
| Cr | Ritzville - divided by 10, Sandpoint - divided by 10 |
| Hf | Oak Ridge data group except for Challis - divided by 10 |
| K | Sandpoint - divided by 10, Challis - multiplied by 10, Spokane - 15 minute blocks, Hailey and Twin Falls - fractionally high |
| Lu | Sandpoint - fractionally high |
| Mg | Poor data - many quadrangles with small inconsistencies, Savannah River data group all fractionally low |
| Mo | Poor data, Challis - fractionally low |
| Nb | Los Alamos data group - divided by 10, Jordan Valley and Idaho Falls - fractionally high, Okanogan - 15 minute blocks |
| P | Ritzville - 15 minute blocks |
| Pb | Poor data |
| Rb | Dillon, Billings, and Butte - fractionally low relative to others in Los Alamos data group |
| Sb | Poor data |
| Sc | Sandpoint - fractionally high |
| Sr | Poor data, Challis - fractionally low, Los Alamos data group - fractionally high |
| Ta | Poor data |
| Tb | Poor data |
| U | Glasgow - divided by 1000, Challis and Sandpoint - fractionally high |
| W | Poor data |
| Zn | Sandpoint - divided by 10 |
| Zr | Los Alamos data group seems to be about 3 times the Oak Ridge data group. No changes made. Oak Ridge data group seems to be better considering normal crustal abundance. |

**Supporting Data**

No attempt was made here to make the supporting NURE data consistent among the quadrangles. Some quadrangles have the state given; other quadrangles, where the samples were collected and analyzed by a different laboratory, do not. Also much of the supporting data are not included with this data. For more information, the user should refer to Hoffman, Gunnels, and McNeal (1991) and Averett (1984).

## Obtaining Digital Data

The digital files for the regional geochemistry data are available as GIS coverages and associated data files. To obtain copies of the digital data, do one of the following:

1. Download the digital files from the USGS public access World Wide Web site on the Internet.

**URL = http://wrgis.wr.usgs.gov/docs/geologic/northwest_region/ICBEMP/ICBEMP.html**

The World Wide Web site contains the same files listed in Tables 1, 3, and 4.

2. Obtain the digital files from the ICBEMP project office. Contact information is given in the section, U.S. Geological Survey involvement, above.

## Concluding Remarks

The NURE geochemical data were collected with great effort to create a good geochemical data set for the United States. It is the most comprehensive, publicly available geochemical data for the Columbia River Basin. A significant effort has been made in this report to improve the available data. Therefore considerable effort has been applied to check these data for errors and to make reasonable corrections. In spite of this effort these data still contain errors; but the data are considered useful, if used with caution and some skepticism. Taken in total the data are useful for regional classification, such as gross chemical differences, especially where these classifications can be compared with independent data, such as lithologic information. In detail, for assessment of absolute differences between areas or for assessment of a specific, small area, such as a small group of stream basins, great care and extreme skepticism must be exercised, especially if the geographic area crosses a $1^0$ by $2^0$ quadrangle boundary. For such uses, it is better to reanalyze the archived samples, which are maintained by the U.S. Geological Survey. Such reanalysis was not feasible for this project. Where such reanalysis has been done in other areas, in some cases the original measurements have not been reproduced and the reanalyses are significantly different. Some of these differences can only be explained by resampling and further analysis to obtain repeatable, valid results. An example of a potentially important error is identified in Table 5 as the 15-minute blocking. Therefore, the user of these data is warned the data are useful but proceed with caution.

## References Cited


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Averett, W.R., 1984, Guide to data reports of the hydrogeochemical and stream sediment reconnaissance: U.S. Dept. of Energy, Report GJBX-5(84).

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## Appendix A: Descriptive information on Arc files.

**Coverage Name:** lanl, oak, and sr
**Descriptive Location:** Columbia River Basin, lanl - East-central Idaho and west-central Montana; oak - Northern Idaho and Montana and southeastern Oregon, and southern Idaho; sr - Southeastern Oregon and northeastern Washington.
**Brief Description:** Columbia Basin NURE regional geochemistry point data. The sample media is dominately stream sediment. Soil samples were used in the few cases where stream-sediment samples were not available. Units are in parts per million (ppm), except for Al, Ca, K, Fe, Na, and Mg that are in percent (%). A value of zero indicates the sample was not analyzed for the element. A negative value indicates an analyzed value at the lower limit of detection.

**SOURCE**

Data Source: USGS Branch of Geochemistry
Telephone: 303/236-1800
Source Material : digital
Source Projection: Latitude-Longitude
Source Date (Publication date): Unpublished
General Comments (disclaimers, qualifications): Each sample point was entered at the latitude and longitude and projected to the ICBEMP projection. These data were received before the National Geochemical Data Base was developed. A source for the total data set is Hoffman, J.D., Bunnels, G.B., and McNeal, J.M., 1991, National geochemical data base - National Uranium Resource Evaluation data for the conterminous western United States: U.S. Geological Survey Digital Data Series, DDS-1. This report is the best place to find documentation defining sample types etc.

**DIGITAL COMPILER**

Responsible Organization/Agency: USGS
Project Name: Columbia River Basin Ecosystem Project
Point of Contact: Gary Raines
Telephone: 702/784-5596

**ATTRIBUTES**

Creation Date: Fall, 1994
GIS ARC/INFO
Feature Types ARC/INFO : points
Topology Present : point
Precision: Single Precision
Archive: Raines, G.L., and Smith, C.L., 1996, Digital maps of National Uranium Resource Evaluation (NURE) geochemistry of the Pacific Northwest: a contribution to the Interior Columbia River Basin Ecosystem Management Project: U.S Geological Survey

lanl.pat (22876 points) Units are in parts per million (ppm), except for Al, Ca, K, Fe, Na, and Mg that are in percent (%). A value of zero indicates the sample was not analyzed for the element. A negative value indicates an analyzed value at the lower limit of detection.

| COLUMN | ITEM NAME | WIDTH | OUTPUT | TYPE | N.DEC | Description |
|---|---|---|---|---|---|---|
| 1 | AREA | 4 | 12 | F | 3 | - |
| 5 | PERIMETER | 4 | 12 | F | 3 | - |
| 9 | LANL# | 4 | 5 | B | - | - |
| 13 | LANL-ID | 4 | 5 | B | - | - |
| 17 | UNIQID | 8 | 8 | C | - | - |
| 25 | LASLID | 8 | 8 | C | - | Identification |
| 33 | LAT | 8 | 8 | F | 4 | Latitude |
| 41 | LONG | 8 | 9 | F | 4 | Longitude |
| 49 | SAMPTYP | 8 | 8 | C | - | Sample type |
| 57 | CONTAMC | 8 | 8 | C | - | Contamination type near sample type. |
| 65 | AG | 8 | 8 | F | 2 | - |
| 73 | AL | 8 | 8 | F | 2 | - |
| 81 | AS | 8 | 8 | F | 2 | - |
| 89 | AU | 8 | 8 | F | 2 | - |
| 97 | BA | 8 | 8 | F | 2 | - |
| 105 | BE | 8 | 8 | F | 2 | - |
| 113 | BI | 8 | 8 | F | 2 | - |
| 121 | CA | 8 | 8 | F | 2 | - |
| 129 | CD | 8 | 8 | F | 2 | - |
| 137 | CE | 8 | 8 | F | 2 | - |
| 145 | CL | 8 | 8 | F | 2 | - |
| 153 | CO | 8 | 8 | F | 2 | - |
| 161 | CR | 8 | 8 | F | 2 | - |
| 169 | CS | 8 | 8 | F | 2 | - |
| 177 | CU | 8 | 8 | F | 2 | - |
| 185 | DY | 8 | 8 | F | 2 | - |
| 193 | EU | 8 | 8 | F | 2 | - |
| 201 | FE | 8 | 8 | F | 2 | - |
| 209 | HF | 8 | 8 | F | 2 | - |
| 217 | K | 8 | 8 | F | 2 | - |
| 225 | LA | 8 | 8 | F | 2 | - |
| 233 | LI | 8 | 8 | F | 2 | - |
| 241 | LU | 8 | 8 | F | 2 | - |
| 249 | MG | 8 | 8 | F | 2 | - |
| 257 | MN | 8 | 8 | F | 2 | - |
| 265 | NA | 8 | 8 | F | 2 | - |
| 273 | NB | 8 | 8 | F | 2 | - |
| 281 | NI | 8 | 8 | F | 2 | - |
| 289 | PB | 8 | 8 | F | 2 | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 297 | RB | 8 | 8 | F | 2 | - |
| 305 | SB | 8 | 8 | F | 2 | - |
| 313 | SC | 8 | 8 | F | 2 | - |
| 321 | SE | 8 | 8 | F | 2 | - |
| 329 | SM | 8 | 8 | F | 2 | - |
| 337 | SN | 8 | 8 | F | 2 | - |
| 345 | SR | 8 | 8 | F | 2 | - |
| 353 | TA | 8 | 8 | F | 2 | - |
| 361 | TB | 8 | 8 | F | 2 | - |
| 369 | TH | 8 | 8 | F | 2 | - |
| 377 | TI | 8 | 8 | F | 2 | - |
| 385 | U | 8 | 8 | F | 2 | - |
| 393 | V | 8 | 8 | F | 2 | - |
| 401 | W | 8 | 8 | F | 2 | - |
| 409 | YB | 8 | 8 | F | 2 | - |
| 417 | ZN | 8 | 8 | F | 2 | - |
| 425 | ZR | 8 | 8 | F | 2 | - |

List of unique sample types in lanl. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| FREQUENCY | SAMPTYP | Definition |
|---|---|---|
| 6 | blank | no data |
| 1470 | 12 or 15 | Choteau quadrangle only, mostly 12 as defined below with some 15. Codes lost in data capture but checked with Hoffman and others (1991) and these were the codes. |
| 10567 | 12 | Wet stream-sediment sample dried at less than or equal to 100 degrees C and sieved to -100 mesh through stainless steel sieves. |
| 9128 | 15 | Dry stream-sediment sample dried at less than or equal to 100 degrees C (if necessary) and sieved to -100 mesh through stainless steel sieves. |
| 1220 | 70 | Wet sediment sample dried at 110 degrees C and sieved to the reported particle size range. Size fields are not retained here; see Hoffman and others (1991) for this information. |
| 2 | 71 | Lake- or reservoir-sediment sample dried at 100 degrees C and sieved to the reported particle size range. Size fields are not retained here; see Hoffman and others (1991) for this information. |

| | | |
|---|---|---|
| 484 | 72 | Dry sediment sample dried at 110 degrees C and sieved to the reported particle size range. Size fields are not retained here; see Hoffman and others (1991) for this information. |

List of unique contamination code in lanl. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| CONTAMC | Definition |
|---|---|
| blank | undefined |
| 1 | chemical |
| 2 | smelting |
| 3 | mining |
| 4 | sewage |
| 5 | dumps |
| 6 | farming/agriculture |
| 7 | power generation |
| 8 | urban |
| 9 | other industrial |

oak.pat (20701 points) Units are in parts per million (ppm), except for Al, Ca, K, Fe, Na, and Mg that are in percent (%). A value of zero indicates the sample was not analyzed for the element. A negative value indicates an analyzed value at the lower limit of detection.

| COLUMN | ITEM NAME | WIDTH | OUTPUT | TYPE | N.DEC | Description |
|---|---|---|---|---|---|---|
| 1 | AREA | 4 | 12 | F | 3 | - |
| 5 | PERIMETER | 4 | 12 | F | 3 | - |
| 9 | OAK# | 4 | 5 | B | - | - |
| 13 | OAK-ID | 4 | 5 | B | - | - |
| 17 | UNIQID | 8 | 8 | C | - | Identification |
| 25 | SRLID | 8 | 8 | C | - | Identification |
| 33 | ORNLID | 8 | 8 | C | - | Identification |
| 41 | LAT | 8 | 9 | F | 4 | - Latitude |
| 49 | LONG | 8 | 9 | F | 4 | Longitude |
| 57 | SAMPTYP | 8 | 8 | C | - | Sample type |
| 65 | CONTAMC | 8 | 8 | C | - | Contamination type near sample type. |
| 73 | AG | 8 | 8 | F | 2 | - |
| 81 | AL | 8 | 8 | F | 2 | - |
| 89 | AS | 8 | 8 | F | 2 | - |
| 97 | AU | 8 | 8 | F | 2 | - |
| 105 | B | 8 | 8 | F | 2 | - |
| 113 | BA | 8 | 8 | F | 2 | - |
| 121 | BE | 8 | 8 | F | 2 | - |
| 129 | BI | 8 | 8 | F | 2 | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 137 | CA | 8 | 8 | F | 2 | - |
| 145 | CD | 8 | 8 | F | 2 | - |
| 153 | CE | 8 | 8 | F | 2 | - |
| 161 | CO | 8 | 8 | F | 2 | - |
| 169 | CR | 8 | 8 | F | 2 | - |
| 177 | CS | 8 | 8 | F | 2 | - |
| 185 | CU | 8 | 8 | F | 2 | - |
| 193 | DY | 8 | 8 | F | 2 | - |
| 201 | EU | 8 | 8 | F | 2 | - |
| 209 | FE | 8 | 8 | F | 2 | - |
| 217 | HF | 8 | 8 | F | 2 | - |
| 225 | K | 8 | 8 | F | 2 | - |
| 233 | LA | 8 | 8 | F | 2 | - |
| 241 | LI | 8 | 8 | F | 2 | - |
| 249 | LU | 8 | 8 | F | 2 | - |
| 257 | MG | 8 | 8 | F | 2 | - |
| 265 | MN | 8 | 8 | F | 2 | - |
| 273 | MO | 8 | 8 | F | 2 | - |
| 281 | NA | 8 | 8 | F | 2 | - |
| 289 | NB | 8 | 8 | F | 2 | - |
| 297 | NI | 8 | 8 | F | 2 | - |
| 305 | P | 8 | 8 | F | 2 | - |
| 313 | PB | 8 | 8 | F | 2 | - |
| 321 | RB | 8 | 8 | F | 2 | - |
| 329 | SB | 8 | 8 | F | 2 | - |
| 337 | SC | 8 | 8 | F | 2 | - |
| 345 | SE | 8 | 8 | F | 2 | - |
| 353 | SM | 8 | 8 | F | 2 | - |
| 361 | SN | 8 | 8 | F | 2 | - |
| 369 | SR | 8 | 8 | F | 2 | - |
| 377 | TA | 8 | 8 | F | 2 | - |
| 385 | TB | 8 | 8 | F | 2 | - |
| 393 | TH | 8 | 8 | F | 2 | - |
| 401 | TI | 8 | 8 | F | 2 | - |
| 409 | U | 8 | 8 | F | 2 | - |
| 417 | V | 8 | 8 | F | 2 | - |
| 425 | W | 8 | 8 | F | 2 | - |
| 433 | Y | 8 | 8 | F | 2 | - |
| 441 | YB | 8 | 8 | F | 2 | - |
| 449 | ZN | 8 | 8 | F | 2 | - |
| 457 | ZR | 8 | 8 | F | 2 | - |

List of unique sample codes in oak. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| FREQUENCY | SAMPTYP | Definition |
|---|---|---|
| 35 | blank | No data |
| 5483 | 12 | Wet stream-sediment sample dried at less than or equal to 100 degrees C and sieved to -100 mesh through stainless steel sieves. |
| 7254 | 15 | Dry stream-sediment sample dried at less than or equal to 100 degrees C (if necessary) and sieved to -100 mesh through stainless steel sieves. |
| 20 | 5 8 | Soil sample sieved to greater than 149 microns (-100 mesh) but less than 1,000 microns (-18 mesh). |
| 4 | 50 | Stream-sediment sample from flowing stream, sieved to less than 149 microns (-100 mesh) and dried at less than or equal to 110 degrees C. |
| 7073 | 59 | Soil sample sieved to less than 149 microns (-100 mesh). |
| 682 | 61 | Stream-sediment sample from dry stream, sieved to less than 149 microns (-100 mesh) and dried if necessary at less than or equal to 110 degrees C. |
| 20 | 8 1 | Dry stream-sediment sample dried at less than or equal to 100 degrees C (if necessary) and sieved to -10 mesh, +35 mesh through stainless steel sieves. |
| 18 | 8 5 | Dry stream-sediment sample dried at less than or equal to 100 degrees C (if necessary) and sieved to -230 mesh through stainless steel sieves. |
| 1 | 8 6 | Dry stream-sediment sample dried at less than equal to 100 degrees C (if necessary) and separated by sedimentation/centrifugation techniques to less than or equal to 63.5 microns and greater than 2.0 micron. |
| 5 | 8 7 | Dry stream-sediment sample dried at less than or equal to 100 degrees C (if necessary) and separated by sedimentation/centrifugation techniques to less than or equal to 2.0 micron. |
| 4 | 96 | Dry natural-pond-sediment sample dried at less than or equal to 100 degrees C and sieved to -100 mesh through stainless steel sieves. |
| 58 | 97 | Dry artificial-pond-sediment sample dried at less than or equal to 100 degrees C and sieved to -100 mesh through stainless steel sieves. |

| | | |
|---|---|---|
| 9 | 99 | Other sediment or rock sample, dry spring-sediment sample dried at less than or equal to 100 degrees C and sieved to -100 mesh through stainless steel sieves. |

List of contamination codes (CONTAMC) in oak. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| Code | Definition |
|---|---|
| A | agriculture |
| B | residential |
| 1 | chemical |
| 2 | smelting |
| 3 | mining |
| 4 | sewage |
| 5 | dumps |
| 6 | farming/agriculture |
| 7 | power generation |
| 8 | urban |
| 9 | other industrial |

sr.pat (4693 points) Units are in parts per million (ppm), except for Al, Ca, K, Fe, Na, and Mg that are in percent (%). A value of zero indicates the sample was not analyzed for the element. A negative value indicates an analyzed value at the lower limit of detection.

| COLUMN | ITEM NAME | WIDTH | OUTPUT | TYPE | N.DEC | Description |
|---|---|---|---|---|---|---|
| 1 | AREA | 4 | 12 | F | 3 | - |
| 5 | PERIMETER | 4 | 12 | F | 3 | - |
| 9 | SR# | 4 | 5 | B | - | - |
| 13 | SR-ID | 4 | 5 | B | - | - |
| 17 | UNIQID | 10 | 10 | C | - | Identification |
| 27 | LAT | 8 | 8 | F | 4 | - Latitude |
| 35 | LONG | 8 | 9 | F | 4 | Longitude |
| 43 | SAMPTYP | 8 | 8 | C | - | Sample Type |
| 51 | CONTAMC | 8 | 8 | C | - | Contamination type near sample type. |
| 59 | AG | 8 | 8 | F | 2 | - |
| 67 | AL | 8 | 8 | F | 2 | - |
| 75 | AS1 | 8 | 8 | F | 2 | - |
| 83 | BA1 | 8 | 8 | F | 2 | - |
| 91 | BE | 8 | 8 | F | 2 | - |
| 99 | CA | 8 | 8 | F | 2 | - |
| 107 | CE | 8 | 8 | F | 2 | - |
| 115 | CO | 8 | 8 | F | 2 | - |
| 123 | CR | 8 | 8 | F | 2 | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 131 | CU | 8 | 8 | F | 2 | - |
| 139 | DY | 8 | 8 | F | 2 | - |
| 147 | EU | 8 | 8 | F | 2 | - |
| 155 | FE | 8 | 8 | F | 2 | - |
| 163 | HF | 8 | 8 | F | 2 | - |
| 171 | K | 8 | 8 | F | 2 | - |
| 179 | LA | 8 | 8 | F | 2 | - |
| 187 | LI | 8 | 8 | F | 2 | - |
| 195 | LU | 8 | 8 | F | 2 | - |
| 203 | MG | 8 | 8 | F | 2 | - |
| 211 | MN | 8 | 8 | F | 2 | - |
| 219 | MO | 8 | 8 | F | 2 | - |
| 227 | NA | 8 | 8 | F | 2 | - |
| 235 | NB | 8 | 8 | F | 2 | - |
| 243 | NI | 8 | 8 | F | 2 | - |
| 251 | P | 8 | 8 | F | 2 | - |
| 259 | PB | 8 | 8 | F | 2 | - |
| 267 | SC | 8 | 8 | F | 2 | - |
| 275 | SE | 8 | 8 | F | 2 | - |
| 283 | SM | 8 | 8 | F | 2 | - |
| 291 | SN | 8 | 8 | F | 2 | - |
| 299 | SR | 8 | 8 | F | 2 | - |
| 307 | TH | 8 | 8 | F | 2 | - |
| 315 | TI | 8 | 8 | F | 2 | - |
| 323 | U | 8 | 8 | F | 2 | - |
| 331 | V | 8 | 8 | F | 2 | - |
| 339 | W | 8 | 8 | F | 2 | - |
| 347 | Y | 8 | 8 | F | 2 | - |
| 355 | YB | 8 | 8 | F | 2 | - |
| 363 | ZN | 8 | 8 | F | 2 | - |

List of unique sample type codes in sr. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| FREQUENCY | SAMPTYP | Description |
|---|---|---|
| 3 | blank | Not defined |
| 1211 | 50 | Stream-sediment sample from flowing stream, sieved to less than 149 microns (-100 mesh) and dried at less than or equal to 110 degrees C. |
| 476 | 59 | Soil sample sieved to less than 149 microns (-100 mesh). |
| 3003 | 61 | Stream-sediment sample from dry stream, sieved to less than 149 microns (-100 mesh) and dried (if necessary) at less than or equal to 110 degrees C. |

List of contamination codes (COMTAMC) for Savannah River Laboratories. Definitions from version 2.3 of A Manual for Interpreting Reformatted NURE Data Files, originally available in Hoffman and others (1991).

| CONTAMC Code | Definition |
|---|---|
| 1 | other |
| 2 | none |
| 3 | chemical |
| 4 | smelting |
| 5 | mining |
| 6 | garbage |
| 7 | farming |
| 8 | grazing |
| 9 | oil field |
| A | recreation |
| B | residential |