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SOFTWARE NOTICE

SPIDER: A Macintosh program to generate normalized multi-element "spidergrams"

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ABSTRACT

SPIDER is a stand-alone application in LIGHTSPEED PASCAL, using the full Macintosh interface, that generates MacDraw format (i.e., object-defined) "spidergrams" for the abundances of up to 20 elements, such as are now routinely used in petrology, mineralogy, and geochemistry. Four standard types of plot are already built into SPIDER: chondrite-normalized or shale composite–normalized rare-earth-element plots and chondrite- or MORB-normalized multi-element plots. User-defined plots are also readily generated. The user has considerable freedom regarding format of input data and order of element: SPIDER accepts both standard tab-delimited data files from other Macintosh applications and FORTRAN-format (column-defined) files as used on mainframes. The order of variables in the input file need not correspond with that required in the final plot: SPIDER will reorder the data as required.

IMPORTANCE OF MULTI-ELEMENT DIAGRAMS

Multi-element plots, on which element contents for a rock or mineral are normalized to a standard material and plotted logarithmically in some preset order (Figs. 1–5), are now a regular feature of the petrological, mineralogical, and geochemical literature, hundreds having appeared by now (Howarth and Turner, 1987). Thompson (1982) called a single pattern a "spidergram," and a collection of these on one plot a "spider-diagram." Such plots are an extension of the now-conventional plots showing 14 rare-earth elements (REEs) normalized to "average chondrite." They are both tricky and tedious to plot by hand, particularly as they rapidly become illegible as the number of patterns increases. They are thus ideal for computerization, allowing ready experimentation to produce the most effective plot for a given data set.

Rock (1988a) detailed a FORTRAN-77 program that generates spidergrams on a range of mainframe devices. Although this version can be run from a microcomputer such as a Macintosh (running suitable terminal emulation software), results proved to be not wholly satisfactory when captured as MacPaint or MacDraw picture files for printing on imagewriters or laserwriters (as opposed to output on desktop plotters). The original version has therefore been fully converted into a stand-alone Macintosh application in LIGHTSPEED PASCAL, which makes better use of the full Macintosh interface and allows the resulting files to be printed with the full Mac editing and publishing facilities.

STANDARD PLOTS AND OTHER OPTIONS

Four standard plot types are already incorporated into SPIDER. The reasons for choosing these are fully detailed in Rock (1988b), while the actual normalizing values used are compiled in Table 1. Figure 1 shows an example of a spidergram of 17 elements normalized to MORB (mid-ocean-ridge basalt). Figure 2 is a spidergram of 18 elements normalized to chondrite values [except for Rb, K, and P, which have been normalized to Sun's (1980) estimates of undepleted mantle]. Figure 3 shows plots of REEs (in order of atomic number) normalized to average chon-

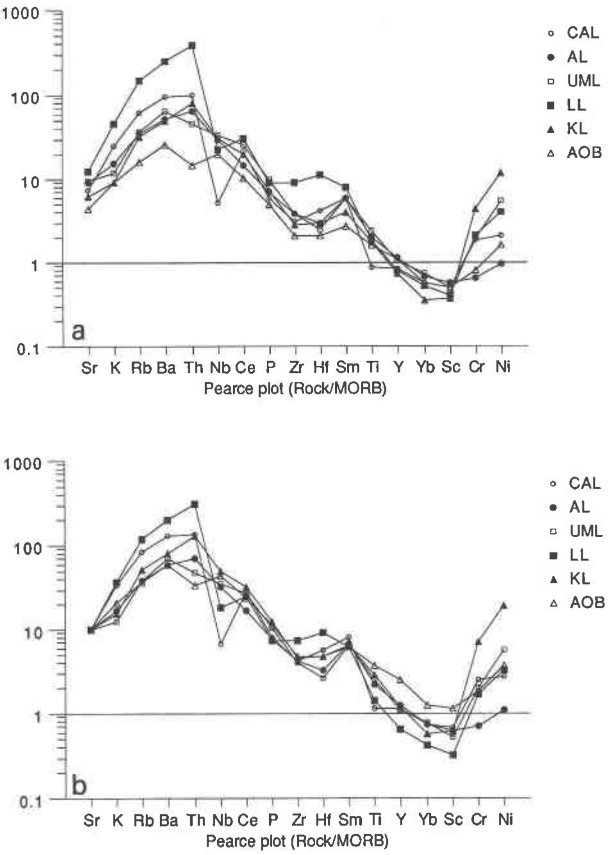

Fig. 1. Examples of MORB-normalized 17-element plots (Pearce, 1983); **(a)** single-normalized, **(b)** double-normalized to Sr = 10. Plotted data are global averages (Rock, 1987) for calc-alkaline lamprophyre (CAL), alkaline lamprophyre (AL), ultramafic lamprophyre (UML), leucite-lamproite (LL), kimberlite (KL), and alkali olivine basalt (AOB).

[1] Executable copies (plus full documentation) are available from the second author, preferably in exchange for other software. Please send your own software on Macintosh 3.5-in. diskettes or IBM-type 5.25-in. floppy disks, which will be returned with SPIDER. Users requesting copies without offering software in exchange are asked to send blank disks in lieu of costs.

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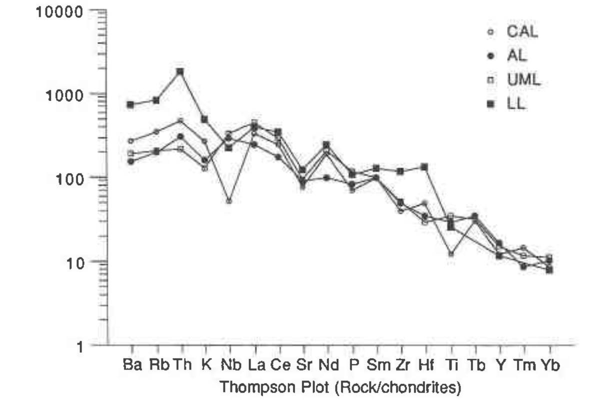

Fig. 2. Example of chondrite-normalized 18-element plot (Thompson, 1982). Plotted data as in Figure 1.

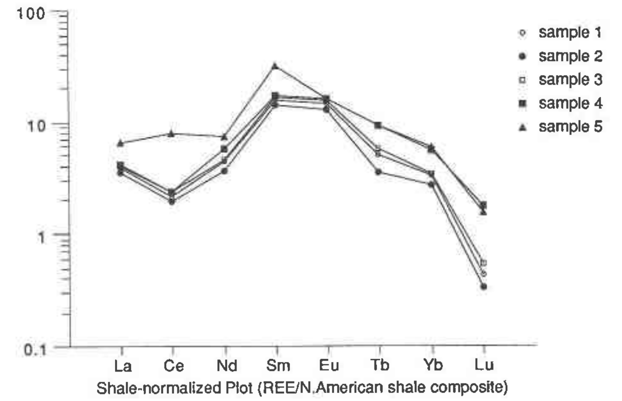

Fig. 4. Example of 8-element REE plot normalized to the North American shale composite. Part of input file shown in Table 2.

drite values, and Figure 4 shows plots of REEs normalized to the North American shale composite (Gromet et al., 1984). Figures 1–4 and 5b were all copied to the Clipboard from SPIDER and thence direct into a MacWrite document (the text of this paper) for immediate laser printing. Figure 5a underwent an intermediate edit in MacDraw.

In addition to standard plots, SPIDER allows the user full rein to devise other types of plots (e.g., Fig. 5), including complete choice of (1) number, order, and names of elements plotted and (2) normalizing values. Declared array sizes in the current version of SPIDER impose only the following constraints on user-defined plots: (1) Maximum number of spidergrams in one spider-diagram = 10 (to avoid clutter). (2) Maximum number of variables in input file = 100. (3) Maximum number of variables on spider-diagram (i.e., ticks on x axis) = 20 (i.e., ≤ 80 extraneous variables can be read in).

SPIDER copes with that very common situation in geology where data files include randomly missing values. On all plots, any element values not >0 are ignored, and lines are drawn continuously only between those symbols representing positive values (e.g., Fig. 3). SPIDER can also generate *double*-normalized plots, on which one element (chosen by the user at run-time) is constrained to a fixed value for all plotted spidergrams (Fig. 1b). Thompson et al. (Fig. 2, etc., in 1984 paper) recommended these for complex plots, as they reduce the amount of overlap between numerous spidergrams and hence clarify the overall spider-diagram.

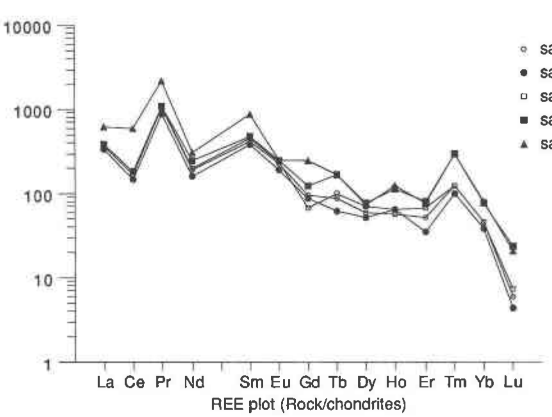

Fig. 3. Example of conventional chondrite-normalized 14-element REE plot. Part of input file shown in Table 2.

TYPES OF INPUT FILE ACCEPTED

SPIDER accepts three file types, each of which must be presented to it as Macintosh Edit documents: (1) Standard, tab-delimited, Macintosh data (individual data items separated by tab characters, records separated by carriage returns). Files are generated in this format by most Macintosh applications (Excel,

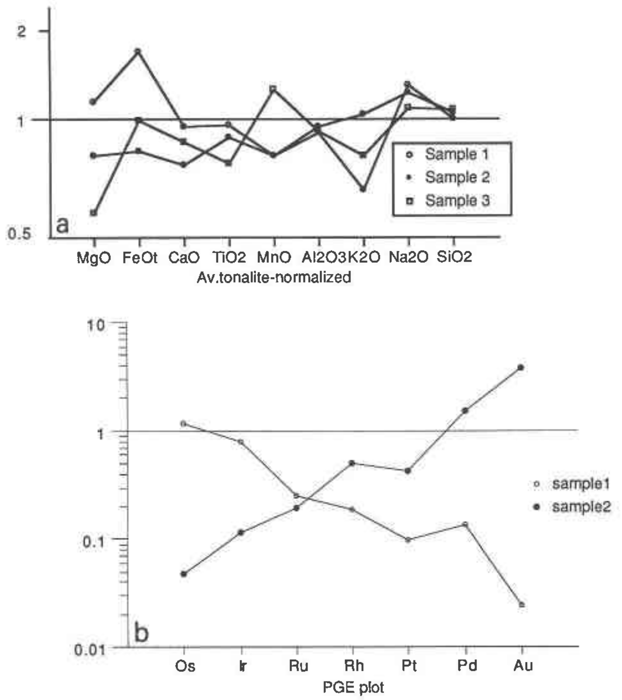

Fig. 5. Examples of user-defined plots. **(a)** Comparison of major-element compositions. This plot has been slightly edited in MacDraw after generation in SPIDER, merely to box the sample key and move its position; the thicker resulting lines are a limitation of MacDraw itself, and they cannot at present be adjusted even by Postscript instructions to the Apple laserwriter. **(b)** Comparison of Pt-group-element (PGE) patterns, with the elements plotted in the conventional order of decreasing melting point and normalized to primitive mantle estimates (0.0018 × C1 chondrites).

TABLE 1. Normalizing values adopted in SPIDER

Values for normalizing 17 element to MORB, as in Pearce (1983)

Sr	K	Rb	Ba	Th	Nb	Ce	P_2O_5	Zr	Hf	Sm	TiO_2	Y	Yb	Sc	Cr	Ni
120.0	0.15	2.0	20.0	0.2	3.5	10.0	0.12	90.0	2.4	3.3	1.5	30.0	3.4	40.0	250.0	90.0

Values for normalizing 18 elements to chondrites, as in Thompson (1982)

Ba	Rb	Th	K	Nb	La	Ce	Sr	Nd	P	Sm	Zr	Hf	Ti	Tb	Y	Tm	Yb
6.9	0.35	0.042	0.0144	0.35	0.328	0.865	11.8	0.63	0.0105	0.203	6.84	0.20	0.103	0.052	2.0	0.034	0.22

Values for normalizing 14 REEs to chondrites (mainly from Nakamura, 1974)

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
0.329	0.865	0.116	0.63	0.203	0.077	0.276	0.052	0.343	0.071	0.225	0.034	0.220	0.0339

Values for normalizing 8 REEs to North American shale composite (Gromet et al., 1984)

La	Ce	Pr	Nd	Sm	Eu	Gd	T	Dy	Ho	Er	Tm	Yb	Lu
31.1	66.7	—	27.4	5.59	1.18	—	0.85	—	—	—	—	3.06	0.456

Note: All trace-element values in ppm; major oxide values in wt%. See Rock (1988b) for further explanation and justification of these values.

Statview, Statworks, File, etc.) and can be simply converted into Edit documents via the Clipboard. For this format, the first line of the file must include the *variable names* (labels), also separated by tab characters (Table 2). These will be printed on the final spidergram exactly as they appear in the input file. (2) As for type 1 but without the first line of labels. In this case, the names of the variables must be revealed to SPIDER via a separate, binary-format definition file, which can be created using program CONVERT (Rock and Wheatley, 1988). (3) Standard mainframe (FORTRAN) format data (individual data items defined by their column positions; no tabs; records separated by carriage returns). This format allows files from mainframes to be read directly by SPIDER (once transferred onto the Mac). Again, the variable names are defined in a binary-format definition file.

SPIDER recognizes variables by their *labels,* without paying attention to case; thus SIO2, SiO2, and SIo2 will all be recognized as the same variable—as will SI, Si, or si—but SiO2, etc., will *not* be recognized as the same variable as Si, SI, or si. Because of the label identification it is not necessary for the variables to be presented in the input file in the same order that they are to be plotted in the final spidergram. SPIDER will automatically compare the list of input and output variables, ignore any variables in the input file that are not to be plotted, insert missing values for those not given in the input file, and switch the remainder into the correct order. Hence, once an input file is read in, several different plots can be generated without leaving SPIDER.

HANDLING PLOTTED SPIDER-DIAGRAMS

Once generated, a plot can be (1) saved directly as a MacDraw document (Fig. 5 was generated in this way); (2) copied to the Clipboard for pasting either into a word processor, if no editing is required, or into a graphics program that can read MacDraw-format pictures (e.g., Superpaint; Figs. 1–4 were all generated in this way); or (3) printed directly on an imagewriter or laserwriter. Special routines using Postscript laserwriter programming language have been incorporated so as to print spidergram lines thinly, as in Figures 1–4; if option 1 is used, however, the lines may appear at the minimum thickness (substantially greater) that MacDraw can handle (Fig. 5a).

TABLE 2. Example Mac, tab-delimited, input file with labels defined in first line

Sample no.	^La	^Ce	^Pr	^Nd	^Sm	^Eu	^Gd	^Tb	^Dy	etc. ¬
sample 1	^120	^143	^120	^119	^86.3	^17.4	^26.9	^4.3	^20.1	etc. ¬
sample 2	^110	^130	^100	^100	^78	^15	^24	^3	^18.0	etc. ¬
sample 3	^124.3	^156.2	^125.3	^124.8	^93.2	^18.2	^18.5	^4.8	^24.4	etc. ¬
sample 4	^127.3	^158.3	^127.8	^157	^97	^19.3	^35	^8	^27.0	etc. ¬
sample 5	^200	^520	^258	^199	^180.	^19	^69	^8	^25.0	etc. (¬)

^ indicates a tab character; ¬ indicates a carriage return character (with no line-feed)

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