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CST Format Data in VC Environment of Earthquake Exploration and Visualization

Zhang Rongxi[a], Zhang Yanmei[b]

[a]*School of Energy Resources, China University of Geosciences (Beijing), Beijing, P. R. China*

Abstract

In this paper, I will discuss the storage format of earthquake exploration data CST, and introduce the read, format transformation and storage of data in VC environment in detail. And finally will introduce the process of visualization of earth quake exploration data CST in VC environment, meanwhile, according to the requirements of data feature and graphical transformation, I use specific solutions and strategies.

Keywords: CST format data; earthquake exploration, VC; graphical visualization

1. Introduction

Nowadays some mature software of geology analysis are popular, most of which are used on large workstations with UNIX operating system. And this design do great help on the tasks requiring large data set dealing and high level of security. However, there are some disadvantages as follows. First, generally workstations are always expensive. Second, UNIX system is based on commands, so that users have to memorize lots of commands for operation, which brings inconvenience.

Along with the development of computer technologies, the functions of computers today are more, in addition, the performance of hardware has been promoted obviously, all of which are the preparation for the complex tasks. Because of these considerations, it would be possible to develop one kind of software for geology analysis based on Windows operating system.Although in the area of earth quake exploration data format, SEG-Y files are commonly used [3], CST format are also widely used, as well, on

* Corresponding author. Tel.: +086-010-13811419196.
E-mail address:zhangrongxi999@163.com

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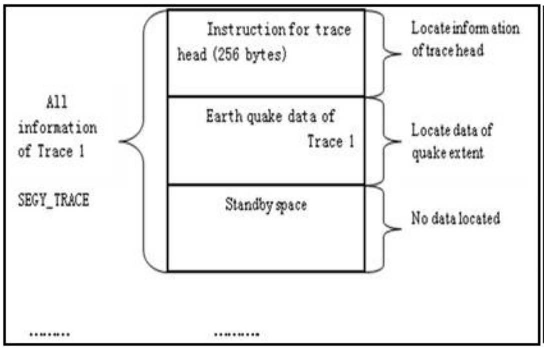
workstations. The purpose of this paper is to discuss the base of geology analysis in Windows system, more specifically, in VC++ environment, which is to read earth quake exploration data, and use visualization methods to simulate the earthquake data, in order to get the information from terrenes. Via selection and match based on data features, we could confirm the subterranean mineral resources, to promote the efficiency and security of geology exploration substantially.

2. Introduction of CST format

The body of CST data is formed with data within traces, and for each trace, there are three parts:
1) Trace head for 256 bytes . 2) Data from sampling. 3) Standby space of 100 bytes.

The information of the 256 bytes trace head is constituted by 64 integer trace heads, and one trace records the data from all sample spot, and reserves with floating format, which all the raw data for plotting earthquake sections. And when dealing with data, all data needed are from data traces. The format of CST data files is showing at figure 1 as follows.



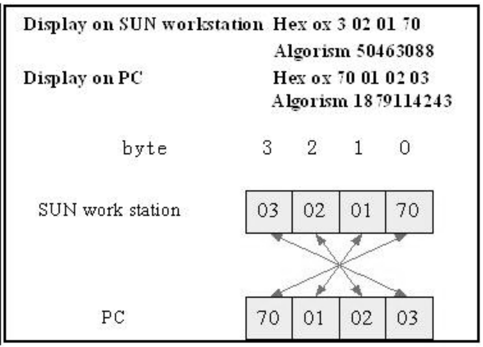


Fig.1.CST earth quake data structure

Fig.2.the difference of integer storage formats between workstation and PC

3. Format transformation

Since there are differences between CPU of SUN workstation and common PC, there are also differences of reservation methods between workstation and PC. The digital order of integer and float 4 bytes are opposite. In this paper, I define two convert loading functions with different parameter styles, in order to implement the data format transformation from workstation to Windows. The two functions will separately deal with the data transformations of int and float styles. I mainly use the bit operation and combo in C language to achieve. To the transformation function of int convert (int data), I use bit operation, according to moving input data to right and "bit providing" in order to arrange the bytes in opposite order. The bit operation of C language is very close to of hardware, so the speed is relatively faster. To the transformation function of float convert (float data), I use combo. The combo is also one function of C language, it could mapping data in memory to two different data styles, in other words, in memory there are two variables point to it. In this function, one byte array with length of 4 (b[4]) and one float number (float f) use the same combo, as well, we use f to read and output the float number and use b to deal with the order of bytes. The advantage to use combo is that it is more understandable than bit operation, and it adds the readability of program. The process of dealing with this issue(figure 2) shows the power of the function of C language.

4. Reading data and creating local files

Considering the speed of data dealing process, because the earthquake data in real practice are large, the processes are always conducted on workstations. If move this process to common computers, it would bring problems concerning speed, actually slower than on workstations. Although the basicfrequency of CPU of personal computer today promoted a lot, the handling capacity is still the bottle neck. The bus system frequency of common personal computer is far lower than the working frequency of workstation. So the handling capacity becomes the bottle neck to restrain the running speed of personal computer. When we read the earthquake wave data, we should not use the methods we using on workstations but do some amendments beforehand. In this paper, the method used is that to reserve the 32 digital floating data as one unit of section, for convenience in the future to create the graph by reading the data.

The exploration data file could be divided into two parts, the first part is trace head information, and the second part is the information for each trace. When defining the input data structure, I design one data structure body: head_info to read and reserve the useful trace head information in files, as well, it could assign values to variables according to their conceptions. To information of each trace, because different sampling spots for each trace, we can not use the data format of structure body, so that in this paper, I use pointer to read and reserve quake extent data of sampling spots in every trace (float format). We use these two data formats to reserve corresponding input data, so that it could clearly classify the formats of input data, as well as confirming the input flows of interface. The data read are transformed to reserve as the local format (EDI). The defined local data format (EDI) as showing at figure 3.

5. The plotting of curve graph

The curve is composed of many short line segments, and the coordinate of each end point of line segments is corresponding to each value, then link these segments can plot the curve. In addition, the graph should meet the requirements of all kinds of transformations, such as the magnitude transformation at horizontal or vertical direction. So when plotting the graph, we should consider the possible situations after operation, and adopt corresponding solutions.

5.1. Automatic Gain Control

The variations in the same earthquake track are always obvious, because there is always strong swing at the initiated sampling point, and as the time goes by, the energy of sampling points decline, so that it requires for gain control. In this system, the gain of the magnification machine at each earthquake track is automatically controlled by its output amplitude independently, small magnification degrees to strong waves while large magnification degrees to weak waves. Besides, there could use the average value of all tracks' output amplitudes to control the gain of each magnification machine. The description of arithmetic method is as follows.

for(first point of track to AGC window length/2)
{Gains of all points = The sum of AGC window length amplitude/ACG window length}
for(the AGC window length of track/2+1 to end)
{Gains of all points = The sum of AGC window length amplitude/ACG window length；
To the last half window, using the average amplitude extend track of the last AGC window length； }
*The data of sampling points *= gains of all points;*

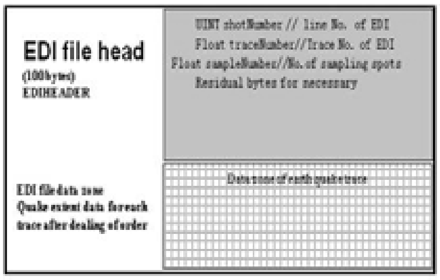


Fig.3. Local file format(EDI)

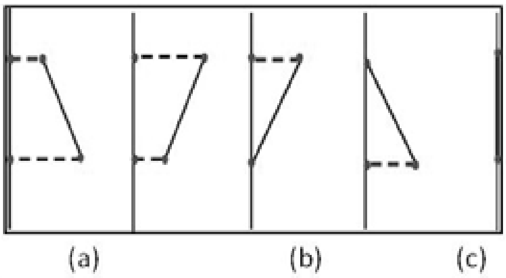


Fig.6.Relationship of neighbor data points and equilibrium position

When we convert the above pseudocode into program, we could get the final coordinates of sampling points according to the different lengths input by users. The result is showing at figure 4.

5.2. The normalization of energy

The value of earthquake data show the strength of amplitudes, positive or negative shows the direction of vibration, and they record the vibration situations of wave testing points at equilibrium positions. These characteristics would not change corresponds with the transformation of graph, so the wave are similar before and after transformation. According to this similarity, we could convert the waveform into certain range while keep the characteristics of the whole waveform, and the coming transformation operations can all be considered as the normal waveform multiplying a coefficient. As a result, a good solution is to normalize the data (to convert the earth quake data into the range of [-1,1], which keeps the relative size of data values, as well, the plus-minus shows the direction of vibration). The normalization of energy: to find the maximum of absolute values of data as the standard value, and then mapping all the values to this standard value (that is to get the ratio of each value to standard value).

The process could be expressed with pseudocode:

if fabs(small value)>fabs(large value) *standard value= small value*
else standard value = large value *mapping value =initial value/ standard value*

5.3. The calculation of coordinators

The earth quake data are standard data, that is for every direction, the data intervals are the same (the intervals of horizontal and vertical data are fixed). The calculations of plotting points' coordinators are correlated with the intervals at horizontal and vertical directions. And the intervals are decided by the density of sampling points and intervals between sampling points, that is the density of measuring points and time intervals. The horizontal direction is the direction of vibration; the X coordinator is codetermined by track intervals and normalized data. First we set the central position of each track, and set the cursor value according to the plus-minus of the normalized data, that is the plus-minus of the cursor value should be the same as the one of the normalized data, and keep the normalized data to vibrate at the central position; as well, the track interval determines the horizontal scaling of image. The formula is as (1) shows.

$$X = \text{Mapping value} + \text{Cursor value} + \text{Track interval} \times \text{Number of Tracks} \qquad (1)$$

The calculation of Y coordinator is related with the position of data point at the track, as (2) shows.

$$Y = \text{Mapping value} / \text{Sampling interval} \times \text{the height of each data point} \qquad (2)$$

We could control the graph display by setting track zoom factor, track length zoom factor, size of AGC time window and maximum amplitude degree, The plotting result is showing at Figure 5.

To represent lineups, in explanation we always display the positive region of earth quakedata with black and the negative region with white, or vice versa.The plot of black-white regional figure is to fill in the polygons. And it also requires the precise judgement to the positive or negative regions of vibration, together with the equilibrium positions of the tracks, we could fill the regions surrounded by positive or negative value and equilibrium positions. However, these regions are always complex, we can not guarantee that they are all convex polygons.As follows we propose the filling of positive value region as an example, to solve the regional filling problem.

1) Identify the relationship between data points and equilibrium positions.

Supposed right to equilibrium positions is the positive value region, if the coordinator value of data is smaller than equilibrium value, in other words, data point is on the left of equilibrium position, we use the equilibrium value to replace this data coordinator value. So it can confirm that the start and end coordinators of region filled are both in positive value region.

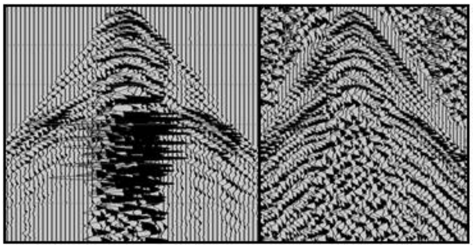
2) Identify the relationship of neighbor data points.

After the first step of data coordinator correction, the neighbor data points only have three relationships as following: a) Both values of the two points are positive, namely, the line linking these two points locates at the right side of the equilibrium position, as showing at Figure 6(a).

b) One point locates at the equilibrium position, and the value of the other point is positive, as 6(b).

c) The two neighbor points both locate at the equilibrium position, as showing at Figure 6(c).

When the neighbor points are all at equilibrium positions, we do not need to fill the region, so that the issue of region filling is simplified to two cases: triangle and echelon. And to fill these two shape regions could be considered as one situation.. After above simplification methods, we convert the black-white region filling to quadrangle filling , as a result, to simplify the program at a large extent.



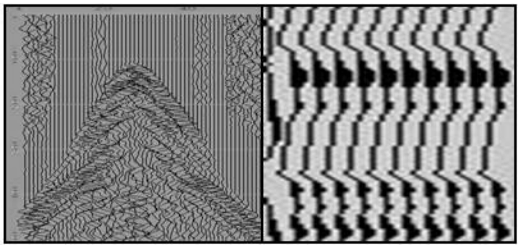


Fig.4.Effect of automatic gain

Fig.5.(a)Curve plotting result;(b)The result of filling region with positive value

6. Conclusion

Nowadays the software development platform of physical geography has started the transition from language to visualized program language. The purpose of writing this paper is to introduce and analyze the foundation of the processor software.

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