CREWES Computer Systems

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ABSTRACT

This paper describes the computer systems and software in use by the CREWES Project. Three large-scale processing systems are discussed in detail: the IBM/Western processing system, the new Sun/ITA system and the Landmark systems. This paper also mentions some of the PC based geophysical and mathematical processing systems used, as well as software used in generating the annual CREWES Project Report. After a description of the CREWES network, the paper ends with several lists which detail the Project's Hardware and Software.

INTRODUCTION

The CREWES Project computer systems are an integral part of the Project's research facilities. The primary uses of our systems are for seismic data processing and research computing. We use a variety of hardware and software combinations to aid in our research, and actively pursue new hardware and software solutions to common Geophysics problems. In cases where no solutions exist, our research involves developing new software. A secondary use of our systems is to aid in the preparation of papers and documents, such as the annual CREWES Research Report.

This year has brought a number of changes to the computer systems. The primary change has been to lessen our dependence on our mainframe system and to begin making greater use of UNIX workstations. We hope to benefit from the interactive features of UNIX workstations, as well as the speed and ease of use they now offer.

IBM/ WESTERN PROCESSING SYSTEM

IBM Canada Ltd. has donated, through a joint-venture agreement, the hardware of the processing system. At the heart of the system is an IBM 4381-Q03 computer. Using system software, donated by IBM, and processing software from Western Geophysical, the IBM 4381 is able to fulfill the project's requirements for processing multi-component data, 2D data, and 3D data.

The IBM 4381-Q03 is capable of performing 6 million instructions per second (6 MIPS). The attached IBM 3838 array processor, can perform 30 million floating point operations per second (MFLOPS). The system has disk drives connected which provide 15 gigabytes of high speed data storage. To archive data effectively, there are four IBM 3480 double unit cartridge drives connected to the system. Lastly, there is an IBM 3420 tape drive which permits the loading of seismic field tapes onto the system.

The IBM system is accessible by way of six IBM 3192G colour graphics terminals, twelve IBM 3279 colour terminals, three 2400 baud modems, or through the local area network. Four IBM text printers provide hard copy output from the system. For plotting seismic plots, we use a Versatec 8242A 42 inch plotter. This plotter is connected through a Logic Science Auscom interface. A Versatec HSR 11A rasterizer is connected between the system and the plotter to help reduce the burden of generating plots on the main processor.

The system has been exceptionally reliable since it was tested and made available to users in May of 1989. Excluding periods of scheduled maintenance, the system has been available more than 99% of the time.

Western Geophysical's complete processing system is installed under IBM's MVS/XA operating system and IBM's JES2 job entry system. Both IBM and Western Geophysical provide execellent support for their software. The Western Geophysical software includes three component data processing, 2D and 3D data processing, interactive job setup using IQueue (Interactive Queue), XED (eXpert EDitor), and complete plotting capabilities. The Seirra modeling package is also available on the IBM 4381 for modeling 2D, 3D, converted-wave, and S-wave data.

SUN / ITA SYSTEM

In the past year, the Department of Geology and Geophysics purchased ITA's "Insight" processing system. This system is available for use by the CREWES Project since it runs on the same Sun systems that CREWES already owns. Collectively, CREWES and the Department have nine workstations that may be used with the ITA software. Over the next year, more of CREWES research work will be performed using the ITA/Sun processing system.

ITA's Insight processing software is a processing suite that runs on a number of common UNIX platforms, including Sun, SGI, Convex and others. Portions of the suite support a graphical user interface, while other parts are driven by text files containing processing commands. The software supports field tape demultiplexing[1], pre-stack and post-stack processing, and a variety of interactive picking and display modules.

The hardware for the new processing system consists of eight Sun Sparcstation 2 workstations and one Sun Sparcserver 470 server. Each workstation performs its own processing and is capable of 21 SPECmarks[2] or 6 MFLOPS (million floating point operations per second). The ITA software supports use of a floating point accelerator card that increases floating point performance to 80 MFLOPS. CREWES plans to purchase such an accelerator in the near future.

Our goal in configuring the Sun systems has been to make each workstation capable of operating at its full potential, independent of the load levels of other systems, while making the user environment as consistent as possible from one workstation to another. The Sun system has been setup with one server system (Sparc-

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1 Demultiplexing is only available on systems fitted with an accelerator card and a VME-connected tape drive.

2 A SPECmark is a measure of computer performance. The DEC Vax 11/780 computer has a SPECmark value of one.

server 470) and a number of ancillary workstations (Sparcstation 2's). The server system has the largest and fastest disk drives. These are used to store application programs and users' personal files. Seismic data processing makes heavy use of disk I/O. To reduce the load on the network and improve I/O performance, each of the workstations has a 700 megabyte disk drive attached. These disk drives serve as data work space and provide additional swap space that is required by the ITA software. Since each workstation has its own CPU and disk, individual workstations are unaffected by the processing load on other workstations. To make the user environment consistent, all our Sun systems use NFS (the Network File System) to make users' files available to them regardless of the workstation they are using.

LANDMARK

An IBM RT workstation and Landmark software was made available to the CREWES Project by Landmark Graphics Corp. under their University Industry Partnership Program. The system is composed of an IBM RT workstation with 16 megabytes of main memory and one gigabyte of disk space. Connected to the RT is a 1/2" round reel tape drive, a color plotter, a printer, a mouse, and two color graphics displays. The system runs the AIX operating system and includes FORTRAN and C compilers. An additional Landmark-configured workstation was purchased by CREWES in the past year. This system consists of a Sun Sparcstation 2, two 19 inch colour monitors, an Exabyte 8mm tape drive and disk space totalling 2 gigabytes.

Landmark has supplied an array of software products for our two Landmark systems under the same University Industry Partnership Program. This software includes 2D Plus, 3D Plus and UNISEIS. 2D Plus and 3D Plus are for interactive interpretation of 2D and 3D stacked seismic sections. The UNISEIS modeling package performs 2D modeling using a variety of geometries. Crosshole, VSP, and multicomponent seismic have all been modeled on UNISEIS and then processed using CREWES processing systems.

PC BASED GEOPHYSICAL AND MATHEMATICAL SOFTWARE

CREWES makes heavy use of personal computer based geophysical software. Amongst these are Vista, GMA's LogM and Struct, Hampson-Russell's AVO and many others. These are listed in detail in the software list at the end of this paper. The Project also uses packages for performing mathematics, statistics and graphing. Theorist and PC-Matlab are commonly used for these purposes.

DOCUMENT PREPARATION

Preparation of the annual CREWES research report is very important. The report is a very complex document since it includes contributions from a large number of authors and includes several diagrams, plots, pictures and tables. In an attempt to simplify the management of this document and to ease its assembly, we have attempted to produce as much of the report by computer as possible. Having an electronic copy of the report enables us to archive the report in a form that will not degrade over time This permits us to make reprints of papers that are first-generation quality.

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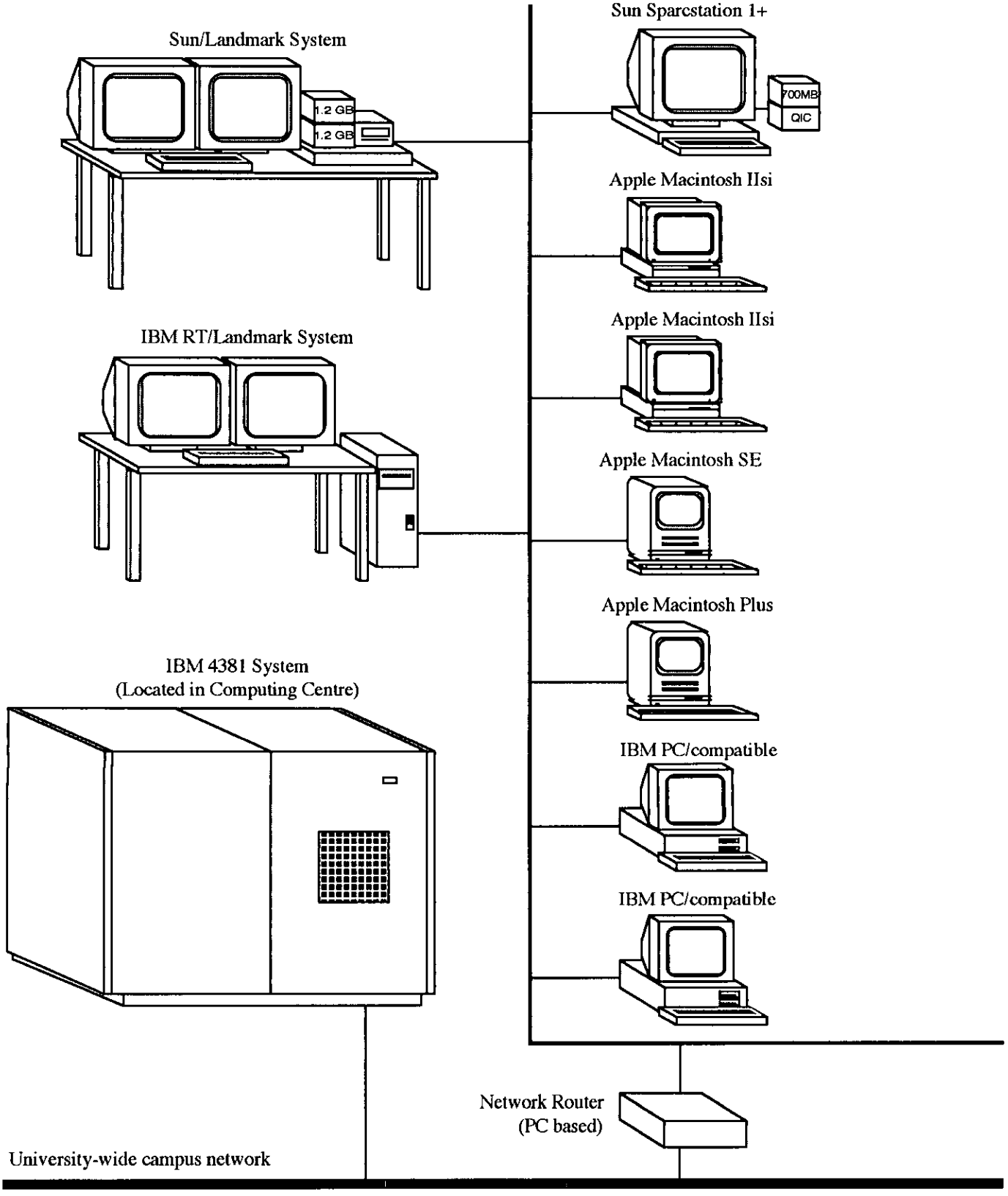

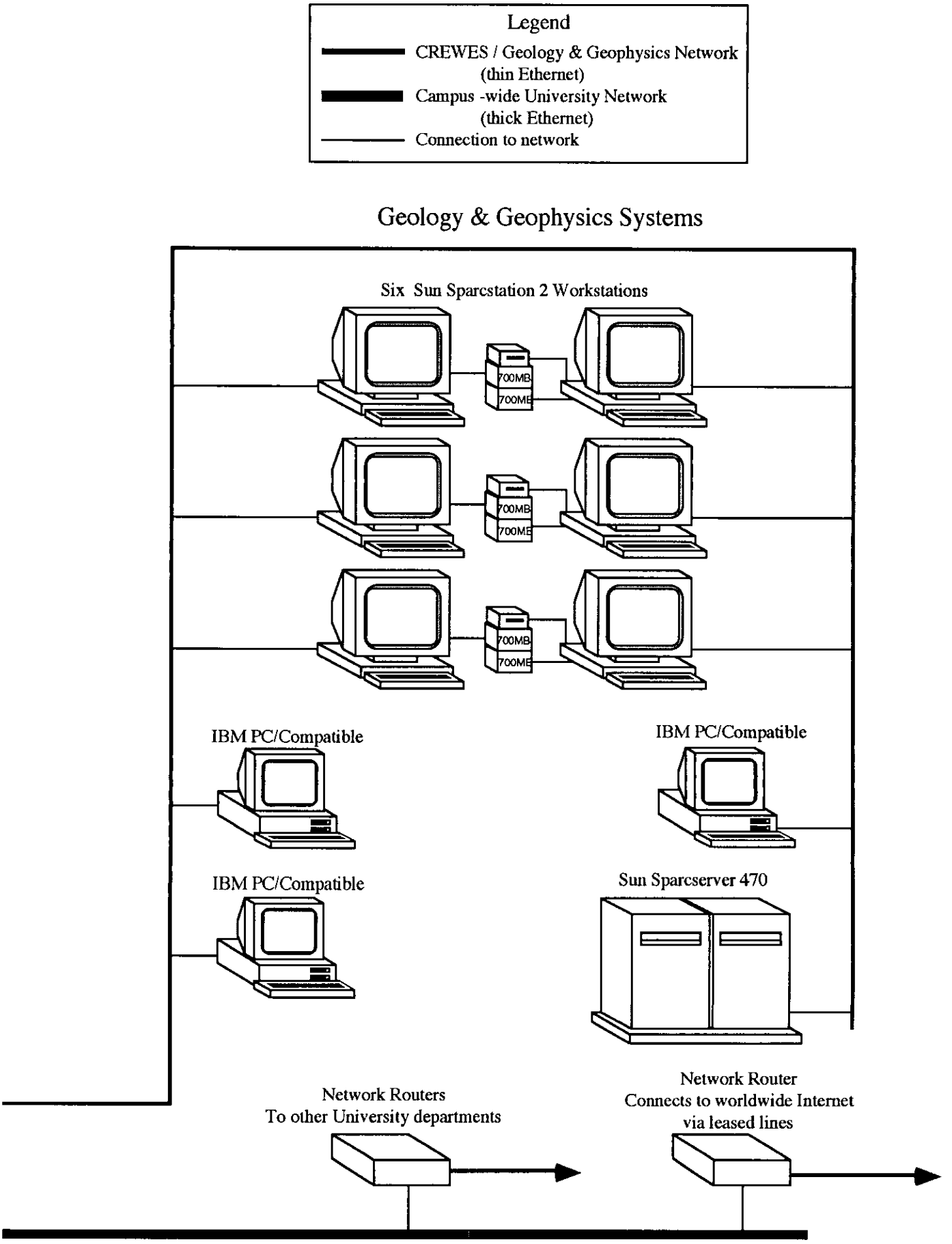
Legend
CREWES / Geology & Geophysics Network
(thin Ethernet)
Campus -wide University Network
(thick Ethernet)
Connection to network
Geology & Geophysics Systems
Six Sun Sparcstation 2 Workstations
700MB
700MB
700MB
700MB
700MB
700MB
IBM PC/Compatible
IBM PC/Compatible
IBM PC/Compatible
Sun Sparcserver 470
Network Routers
To other University departments
Network Router
Connects to worldwide Internet
via leased lines

The majority of the report is prepared on Apple Macintosh computers using Microsoft Word and Aldus Pagemaker for word processing. Many of the diagrams are produced using Deneba's Canvas drawing package, while most of graphs are produced by Cricket Graph. Some of the other images are scanned from paper originals using a flat-bed scanner and Adobe Photoshop software. A smaller portion of the report is generated using PC word processing and drawing packages, such as Wordperfect, Drawperfect and Kinetic Words, Graphs, and Art.

NETWORK

Due to the distributed nature of our data processing facilities it has been vital that all our systems communicate easily and rapidly. To reach this goal we use an Ethernet based network running two common networking protocols: IP (TCP/IP) and Appletalk. The two networking protocols support features such as file sharing, remote system access, printer sharing and electronic mail.

The CREWES network is connected to the Internet network which connects most universities in Canada and the United States as well as companies and research organizations around the world. This connection is made possible through a connection to the University of Calgary's network that is part of the Internet network. This connectivity allows us to exchange information and data with others doing research in similar fields. The wide area network has also been very useful for obtaining free software developed at other universities.

All our systems support two standard IP network programs: Telnet and FTP. These programs are programs for remote system access and network file transfers respectively. Our UNIX systems have the additional capability of supporting NFS (the Network File System). NFS makes disk drives that are connected to any single computer accessible from all other computers on the network.

A recent addition to our network has been the addition of Appletalk support to our Sun systems. The Appletalk networking protocol shares some of the features of the IP protocol: file sharing, electronic mail, and printer sharing. The primary benefit of adding Appletalk support to our Suns is that our Macintosh computers can make use of the Suns as file servers. Users can save their Macintosh files directly into their accounts on the Sun systems in the same manner that they would store their files on a personal floppy disk. User files can then be backed-up on a frequent basis from one central location. The Sun systems benefit from Appletalk as well. Using the Appletalk protocol, the Sun systems can print to any of the Appletalk network printers, such as our Apple LaserWriter printer.

ACKNOWLEDGEMENTS

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HARDWARE LIST

IBM 4381-R14
- IBM 3838 Array processor
- FPS 5605 Array processor
- Disk space totalling 15 gigabytes
- eight IBM 3480 cartridge drives
- 12 color terminals
- 6 graphics terminals
- 4 printers

Sun Sparcstation 2
- two 19" colour displays
- Exabyte 8200 tape drive
- Disk space totalling 2.5 gigabytes

Sun Sparcstation 1+
- 19" colour display
- Quarter inch cartridge tape drive
- Disk space totalling 700 megabytes

Sun Sparcserver 470 (University owned)
- 9 track "round reel" tape drive
- Versatec Plotter Controller
- Quarter inch cartridge tape drive
- CD ROM drive
- Disk space totalling 3 gigabytes

Six - Sun Sparcstation 2 (University owned)
- 19" colour display
- Archive Python DAT tape drive
- Disk space totalling 800 megabytes per workstation

IBM RT/Landmark
- Disk space totalling 900 megabytes
- Dual 19" colour graphic displays
- 9 track "round reel" tape drive
- Colour thermal transfer plotter

Personal Computers
- IBM PC/RT
- Zenith 286 (IBM PC compatible)
- 2 Apple Macintosh IIsi
- Apple Macintosh SE
- Apple Macintosh Plus
- IBM PS/2 Model 70

High Capacity Data Media capabilities
- 9 track "round reel" tape (1600, 6250 BPI)
- Quarter inch cartridge
- DAT (Digital Audio Tape)
- Exabyte (8mm Video Tape)
- CD ROM

Plotters/Printers
- Versatec C2700 Thermal colour plotter
- Versatec 8242A 42" plotter
- Versatec 8224 24" plotter (University owned)
- IBM 3203 Channel attached printer
- Versatec ECP42 42" colour plotter (University owned)

SOFTWARE LIST

The following list describes all the software we use on a regular basis. This list excludes system software, compilers, system utilities and lesser-used software. Although care has been taken in preparing this list, it is likely that portions of the list are inaccurate or out of date. For this reason, this list should be considered a guideline only, and not a source of authority for product information

Modeling			
Package	Vendor	Description	Operating System
MIMIC	Sierra	Geologic modeling and mapping; preparation of models for ray tracing	MVS/XA
QUIK	Sierra	2D & 3D seismic ray tracing field short records, CMP gathers, stacked sections before and after time migration, VSP,.P, S, and converted waves.	MVS/XA
VESPA	Sierra	Wave equation migration; shot records, VSPs, offset VSPs	MVS/XA
SLPR	Sierra	Display of results on screen or hard copy	MVS/XA
Uniseis	Applied Geophysical Software inc.	2D Raytrace modeling for offset, normal incidence, normal emergence, VSP, or crosshole geometries. P, S and converted waves	AIX (Landmark)
LogM	GMA	Well log based seismic modeling; display & edit well logs, synthetics, geologic & seismic cross-sections	MS-DOS
Struct	GMA	Seismic modeling of structural geology using vertical incidence or normal incidence ray tracing or diffraction modeling	MS-DOS
AVO	Hampson-Russell	Interactive AVO modeling, analysis, and inversion.	MS-DOS
Outrider	Microseis Technology	Multicomponent modeling	MS-DOS

Processing			
Package	Vendor	Description	Operating System
IQUEUE	Western Geophysical	Interactive processing environment	IBM MVS/XA
SFM	Western Geophysical	Seismic function modules for selection in interactively creating a processing flow	MVS/XA
XED	Western Geophysical	Expert editor providing interactive parameter entry and interactive help	MVS/XA
Insight/1	ITA	Complete processing package including demultiplexing, pre-stack and post-stack processing with interactive displays	SunOS (Unix)
Vista	Seismic Images Software	Interactive seismic processing from shot record to final stack, synthetic seismograms.	MS-DOS
FDTools	Seismic Images Software	Design 3D surveys, acquisition parameters	MS-DOS
Vista Vision	Seismic Images Software	Seismic plotting program for Vista output files	MS-DOS
Wellpro	Genix Systems	Interactive VSP processing	MS-DOS
PCVSP	Kostelnick	One layer crosswell & VSP ray tracing	MS-DOS
Strata	Hampton Russell	Post-stack seismic inversion and processing. Well log manipulation	MS-DOS

Interpretation			
Package	Vendor	Description	Operating System
2D Plus	Landmark	Interpretation of 2D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (Landmark)
3D Plus	Landmark	Interpretation of 3D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (Landmark)

Mathematics			
Package	Vendor	Description	Operating System
PC Matlab	Mathworks	Mathematics and statistics package with 2D and 3D graphing capability	MS-DOS
Theorist	Prescience	Mathematics and statistics package with 2D and 3D graphing capability	Macintosh
Cricket Graph	Cricket Software	Graphing; simple statistics and data manipulation	Macintosh

Document Processing			
Package	Vendor	Description	Operating System
Word	Microsoft	Word processing with equation capability	Macintosh MS-DOS
Wordperfect	Wordperfect Corporation	Word processing with equation capability	MS-DOS
Expressionist	Allan Bonadio Associates	Visual mathematical equation editor	Macintosh
Canvas	Deneba	Drawing, slide making	Macintosh
Words, Graphs & Art	Kinetic	Visual Presentation Software	MS-DOS
Photoshop	Adobe	Scanning and image processing (colour and B&W)	Macintosh

Miscellaneous			
Package	Vendor	Description	Operating System
Digirule	Digitech	Digitizing of well logs, seismic horizons, etc	MS-DOS
AXXSES	Digtech	Modem access to well data (locations, tops, production, cores, etc) and well-log digits.	MS-DOS
Norton Utilities	Norton	Disk and system management utilities	MS-DOS Macintosh
Quattro	Borland	Spreadsheet with graphing, database, statistics and data manipulation capabilities	MS-DOS
Lotus 1-2-3	Lotus	Spreadsheet with graphing, database, statistics and data manipulation capabilities	MS-DOS