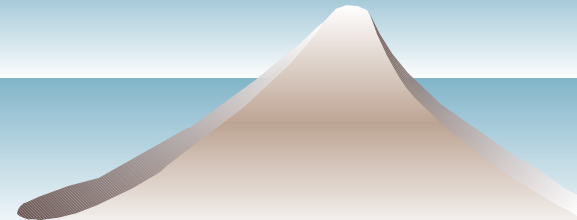


Removable Storage and Computer Interfaces

JICA Computer Science Course
in 2009

H. Miyata



Contents

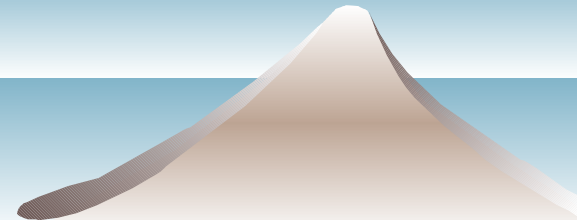
▲ Preface

▲ Computer Interfaces

- IDE(ATAPI)
- SCSI
- USB
- etc.

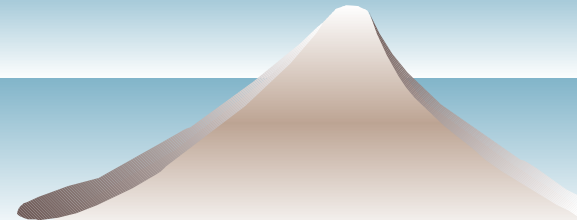
▲ Storage Devices and Media

- CD, DVD
- Flash memory
- MO
- etc.

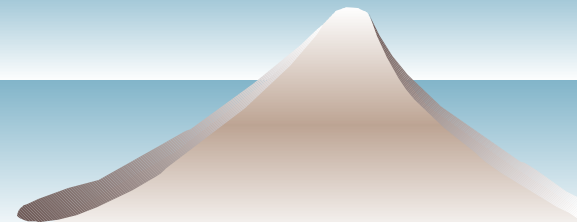


Preface

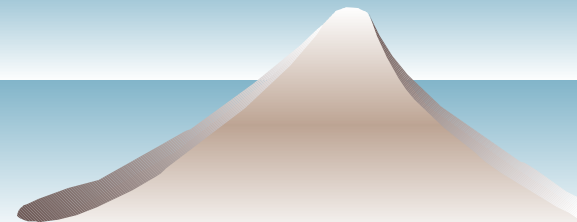
- ▲ The file sizes of multimedia data such as pictures, PCM sounds and digital video data are usually very large even if they are compressed.
- ▲ To keep a lot of multimedia data in the hard disks disturbs the efficient utilization of PC's.



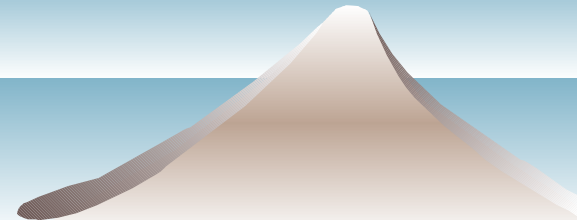
- ▲ Among the ways to solve this problem is to store these data in removable storage media.
- ▲ So, the removable storage is of special importance for multimedia technology.



- ▲ To connect these devices to a PC, several interfaces described below are available.
- ▲ Since each device is usually dedicated to a single interface, it is important to determine which interface should be adopted when we buy a new storage device.

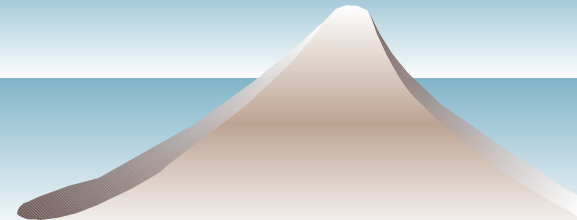


- ▲ Each interface has its own characteristics.
- ▲ The development of the storage devices and PC interfaces to connect them is rapid.

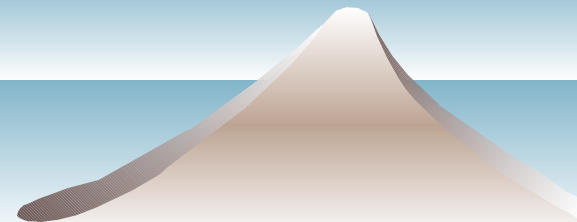


Computer Interfaces

- ▲ Among interfaces, IDE, USB, Centronics and RS-232C interface are furnished in usual PC main boards.
- ▲ Others should be equipped by extension boards or PCMCIA cards.



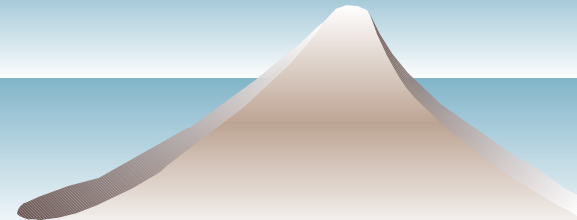
- ▲ Some PC mainboards with new interfaces can be found.
- ▲ Instead, some notebook PC of new type is omitting the old interfaces (RS-232C and Centronics).



1) IDE (ATAPI)

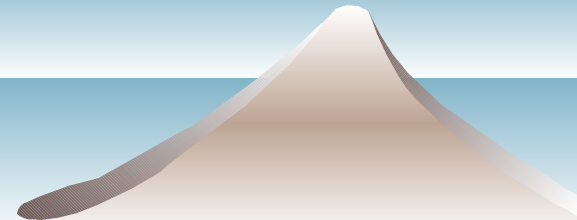
Intelligent(integrated) Drive(device) Electronics

- ▲ It is originally used to connect internal HDD and is also called ATA (AT attachment).
- ▲ It was standardized 1988 and has been extended repeatedly since then.

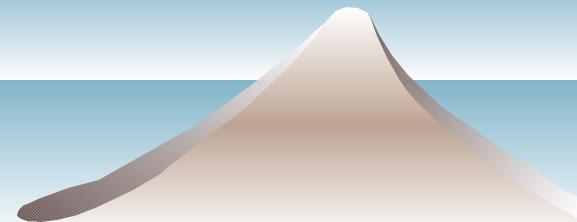


E-IDE

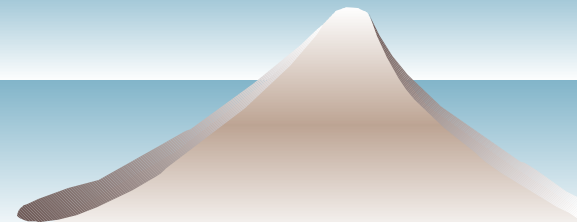
- ▲ The first important extension is E-IDE (Extended IDE) which includes four issues:
 - a) ATAPI (AT attachment packet interface), which is the specification to connect drives other than HDD to IDE, e.g. CD-ROM drives and things like that.



- b) The enlargement of the storage size of HDD. The original IDE can connect only HDD's of 528MB max, which has been extended to 8.4GB.
- c) Number of connectable devices is extended to 4 from 2.

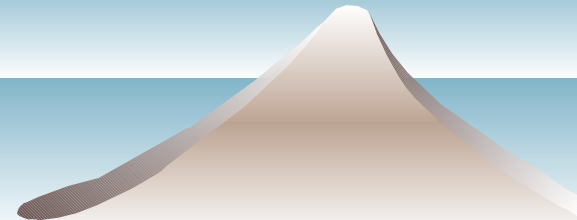


- d) The maximal data transmission speed is increased to 13.3MB/sec from 5MB/sec.
- ▲ The further extensions has been made for the storage size of HDD and the transmission speed since then.



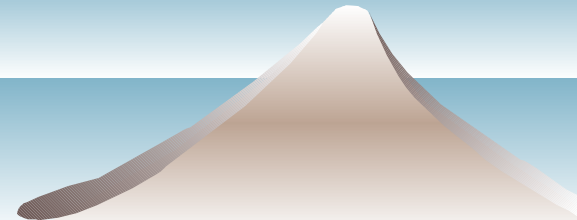
Ultra ATA

- ▲ The new standard of transmission speed is called Ultra ATA with the value 33MB/sec.
- ▲ Subsequently, it has developed to Ultra ATA/66 and then Ultra ATA/100 and Ultra ATA/133 with the speeds 66, 100 and 133MB/sec, respectively.

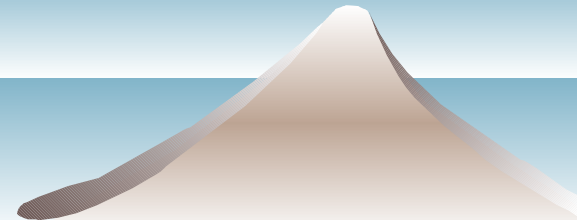


IDE on main boards

- ▲ Since all the main boards of PC's have this interface (and Serial-ATA described below), this is the most popular and easiest (cheapest) way to connect various devices with high speed.

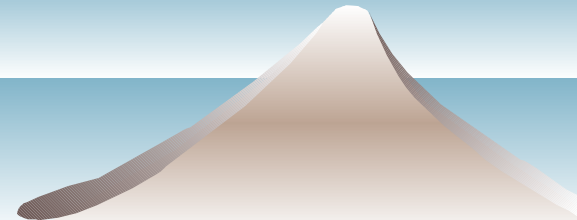


- ▲ But the connection of devices are restricted to internal ones owing to the limit of cable length, unless PCMCIA card is used.



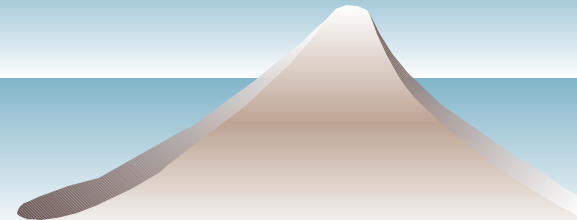
IDE sockets

- ▲ There are usually 2 (parallel) IDE sockets on the main board and 2 IDE devices are connectable to each socket by an IDE cable which has 2 connectors for devices.
- ▲ 2 devices on the IDE cable should be distinguished as “master” and “slave” by setting their jumper switches appropriately.



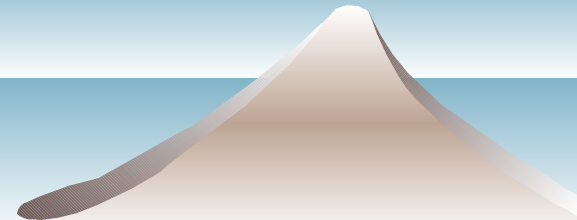
IDE devices

- ▲ There are almost all kind of storage device to connect IDE now, with the limitation that almost all of them are for internal connection.

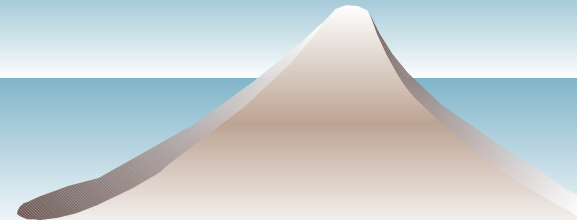


Serial-ATA

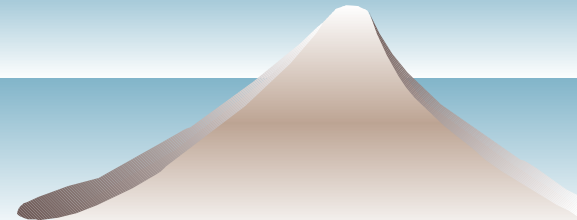
- ▲ a new standard defined by "Serial ATA Working Group" in 2003 to attain higher transmission speed than conventional (parallel) ATA by changing the transmission method to serial.



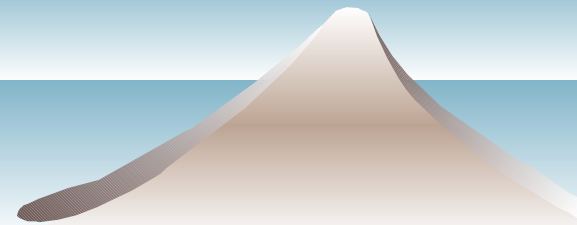
- ▲ This has the speed 1.5 or 3.0 Gb/sec (150 or 300MB/sec, respectively, since 10 bits are used to transmit 1 byte) and already has become the standard of the interface to connect HDD's.



- ▲ For this interface, the serial-ATA socket and cable are used which is smaller (thinner) than usual IDE (parallel-ATA) ones.

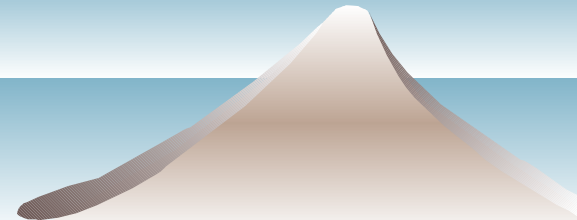


- ▲ Since only one device is connectable to one cable, jumper setting (to select Master or Slave) of the device is not necessary. Hot swapping is supported.



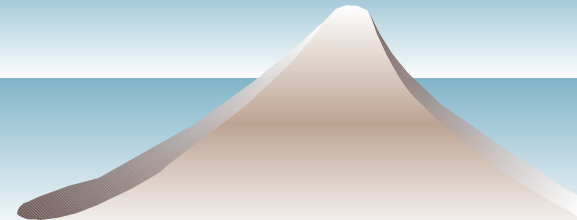
eSATA (external-SATA)

- ▲ the extension of SATA to connect external devices, since the maximal length of SATA cable is 2 m.
- ▲ The shape of the connector differs from that of internal SATA.



2) SCSI (Small Computer System Interface)

- ▲ SCSI (pronounced as “skuzzy”) has been the most popular interface to connect storage devices, especially for external devices since IDE does not support external devices.



- ▲ SCSI has the special importance for its highest performance and reliability in data transmission.
- ▲ There are several standards of SCSI as its development:

a) SCSI-1

(Basic) SCSI	8bit-para.	5MB/sec
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b) SCSI-2

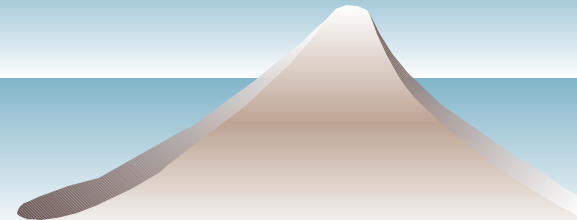
Fast SCSI	8bit-para.	10MB/sec
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Wide SCSI	16bit-para.	20MB/sec
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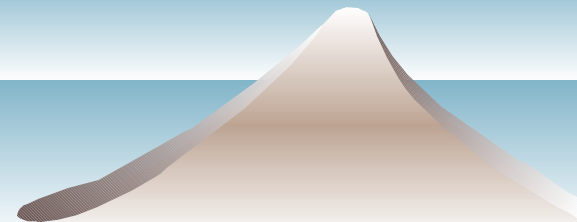


c) SCSI-3

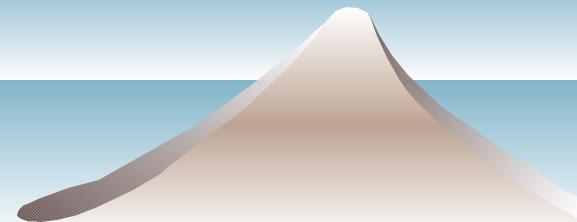
Ultra SCSI	8bit-para.	20MB/sec
Ultra Wide SCSI	16bit-para.	40MB/sec
Ultra Wide SCSI	16bit-parallel	40MB/sec
Ultra2 SCSI	8bit-parallel	40MB/sec
Ultra2 Wide SCSI	16bit-parallel	80MB/sec
Ultra160 SCSI	16bit-parallel	160MB/sec
Ultra320 SCSI	16bit-parallel	320MB/sec



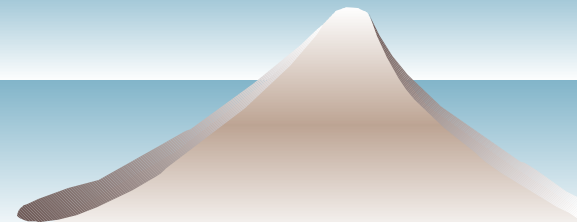
- ▲ SCSI supports both internal and external devices.
- ▲ Usually a SCSI board (host adapter) is necessary to use SCSI devices, unless included in the main board.



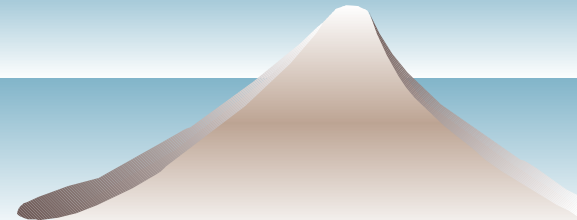
- ▲ Up to 7 devices can be connected to one SCSI adapter board by chaining (each usual SCSI device has two connector sockets for this purpose).
- ▲ Each device in a chain should have unique SCSI ID (number 0-6) which is assigned by its (dip or rotary) switch.



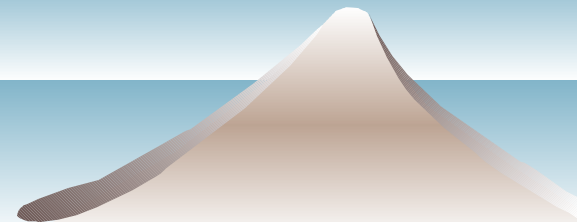
- ▲ The SCSI terminators should be attached to the empty sockets of the end devices of a chain.
- ▲ There are several shapes of sockets of SCSI devices, which makes SCSI connections troublesome.



- ▲ If the performance and reliability be taken account at the same time, the SCSI devices are the best choice,
- ▲ although they are more expensive than the devices of the other interfaces in addition to the cost of SCSI boards.

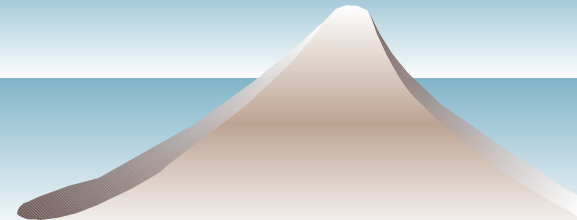


- ▲ But the importance of this interface is decreasing owing to the emergence of new fast interfaces such as IEEE1394 and USB2.0.

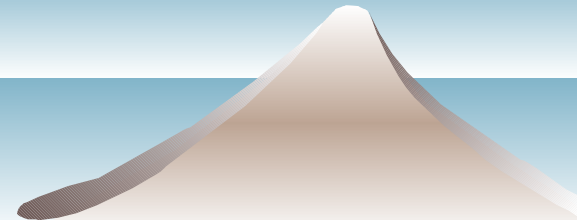


SAS (Serially Attached SCSI)

- ▲ This is defined to realize the higher performance by simplifying the transmission method to serial like SATA.
- ▲ It has the speed 300MB/sec with smaller socket and cable.

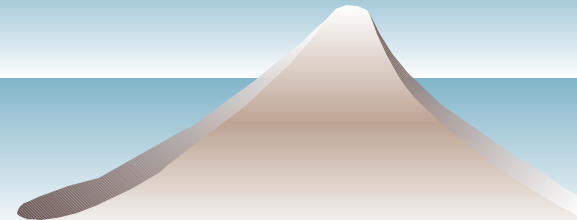


- ▲ The connector has the compatibility with SATA and an SATA device is connectable to an SAS socket (although the reverse is not possible).
- ▲ In near future the speed will be extended to 600MB/sec and further 1.2GB/sec is expected to appear.

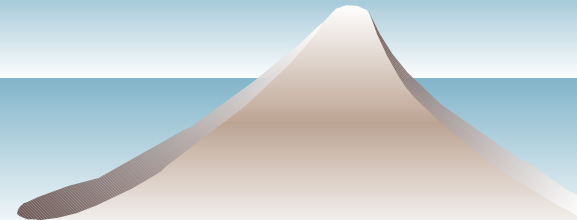


3) USB (Universal Serial Bus)

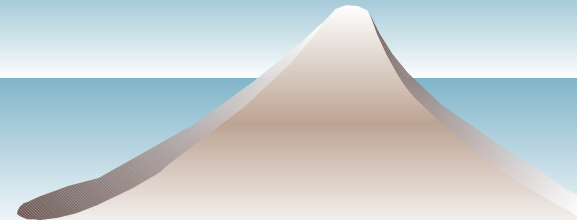
- ▲ This is the new interface to connect various peripherals to a PC, e.g. keyboard, mouse, printer, scanner, FDD, modem, speaker, joystick etc.



- ▲ Traditionally these devices are connected to separate interfaces or sockets.
- ▲ USB has been introduced to unite these connections and to make the usage of peripheral devices easier.

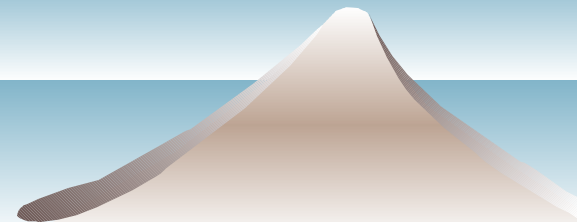


- ▲ Up to 127 devices can be connected to one PC using USB hubs.
- ▲ Now USB has established the position of the easiest way to connect external devices.
- ▲ There are two types of USB, i.e. USB1.1 and 2.0 stated below.

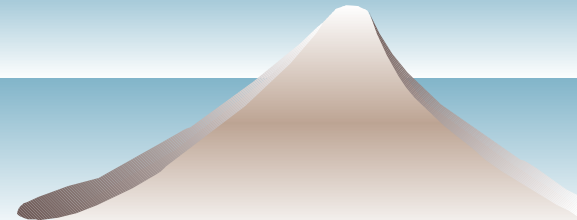


[1] USB1.1

- ▲ USB1.1 is for devices of relatively slow data transmission speed.
- ▲ It is not intended to connect storage devices.
- ▲ Until a few years ago USB of all desktop and notebook PC's has been USB1.1.

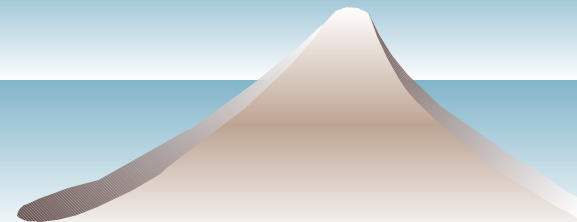


- ▲ The maximal data transmission rate is 1.5MB/sec which is lower than IDE and SCSI above but higher than Centronics and RS-232C below.

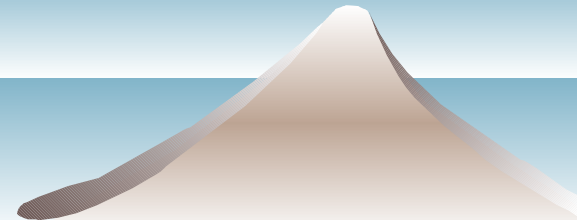


[2] USB2.0

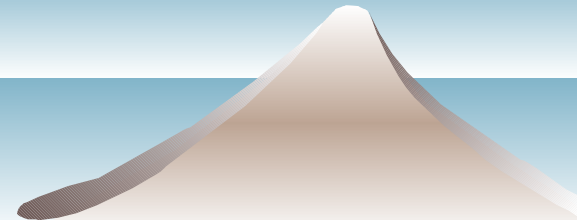
- ▲ This is the new standard of USB with the speed high enough to connect storage devices in high performance (60MB/sec), which compete with IEEE1394.



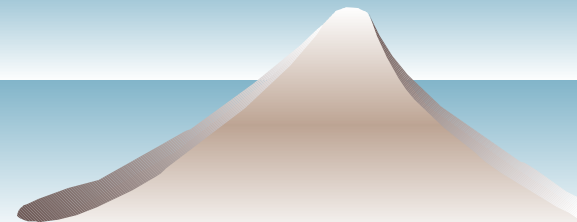
- ▲ Almost all PC-mainboards, consequently, new models of PC sold now are equipped with this interface
- ▲ Almost all kind of storage devices for this interface is on sale.



- ▲ USB 2.0 has become the most powerful PC-interface now.
- ▲ It might make the other interfaces unnecessary except ATA.

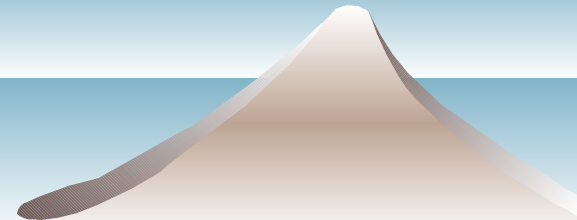


- ▲ This interface has the compatibility with USB1.1, namely the USB1.1 devices can be connected to the USB2.0 sockets and vice versa although the transmission speed becomes lower to that of USB1.1.

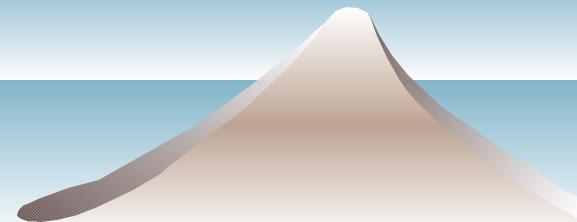


4) IEEE1394

- ▲ This is the serial interface of high speed (50MB/sec max.) defined to improve the performance of SCSI standardizing “Firewire” of Apple company.
- ▲ But it has taken another way of development than that of SCSI.

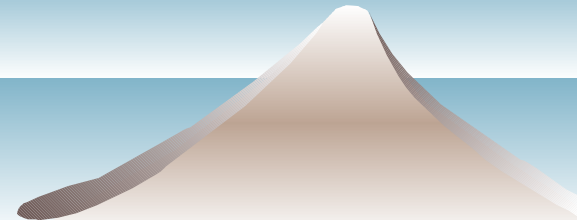


- ▲ It is also called “i.Link” and “DV terminal” and used as the interface to send video signal connecting digital video cameras and decks each other or to a computer.
- ▲ It is equipped to some models of notebook computers.

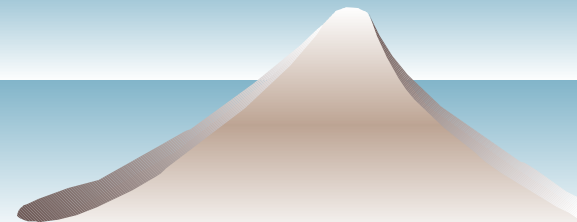


5) Centronics

- ▲ This interface is also called “parallel port” and is usually used to connect printers.
- ▲ The data transmission speed is much slower than above interfaces and is not so important for storage devices.

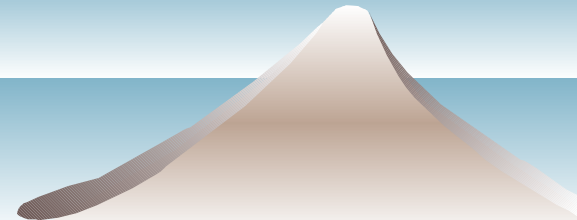


- ▲ There existed some storage devices for this interface before the emergence of USB, because they can be connected without any additional extension board of PC.
- ▲ This is becoming obsolete together with RS-232C in the new standard of PC interfaces and the shift to USB is recommended.

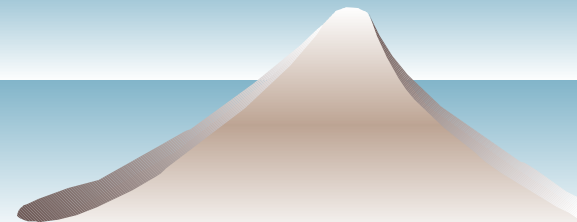


6) RS-232C

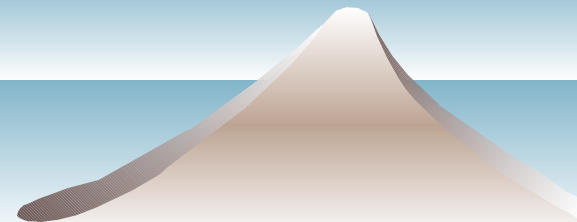
- ▲ This is also called the “serial port”.
- ▲ It is usually used to connect modems, computer-controllable devices (some special model of audiovisual devices has this socket) or MIDI devices with appropriate conversion adapter.



- ▲ The speed of data transmission is about 56kbits/sec.
- ▲ It is too slow to connect storage devices.
- ▲ Its importance in multimedia technology existed as an interface to control multimedia devices such as videos and MD decks.

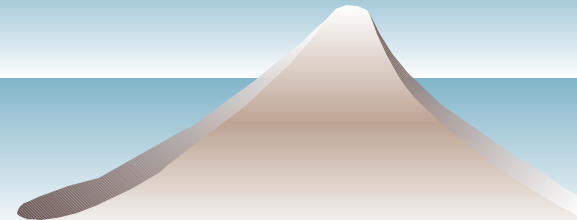


- ▲ Now, this has also the problem as a legacy interface and the shift to USB is also conducted for the functions stated above.
- ▲ The adapter which transforms signals of USB and those of serial port into each other, is available.



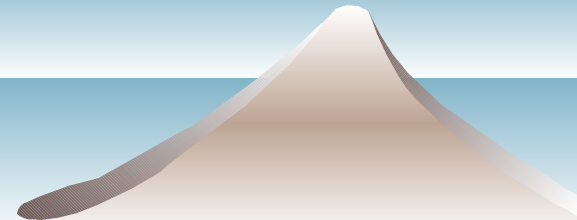
7) PCMCIA socket

- ▲ This is usually furnished to notebook computers.
- ▲ It amount to the extension socket of desktop computers rather than an interface.
- ▲ Many of above mentioned interfaces are realized by PCMCIA cards (which amount to extension boards) for this socket.

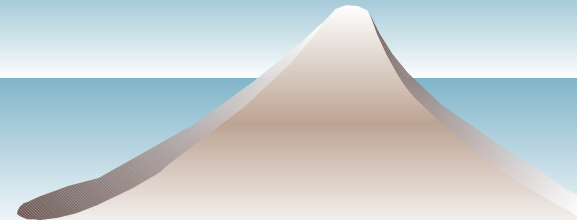


8) LAN socket

- ▲ Several years ago, it was furnished by the extension board and transmission speed was 10Mbps (10Base-T standard),
- ▲ but all mainboards (and then new PC's) sold now have this interface of higher speed (100Mbps or further 1000Mbps).



- ▲ LAN socket is naturally for connecting a computer to other computers,
- ▲ but it is also available to connect the external storage (called LAN disk).
- ▲ So, it is now an important interface to connect external storages.



9) Sound interface

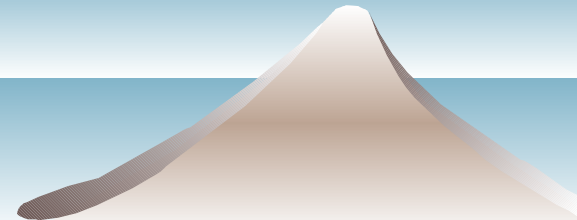
- ▲ This was the function of the sound board but now almost all PC mainboard include this interface.
- ▲ It contains input (line and microphone) and output (speaker) socket, both of which are the only analogue interfaces of PC, though some mainboards have the digital ones also.



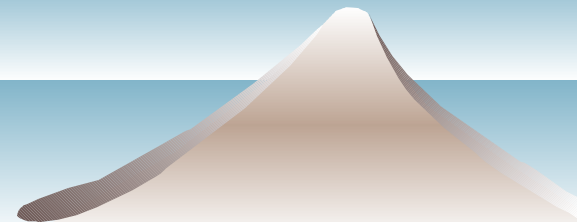
Storage Devices

1) Hard Disk

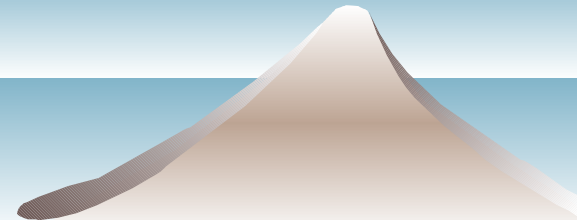
- ▲ Hard disk is the most important storage device and most of internal disks are connected to IDE.
- ▲ For external connection of HDD, SCSI has been used for a long time.



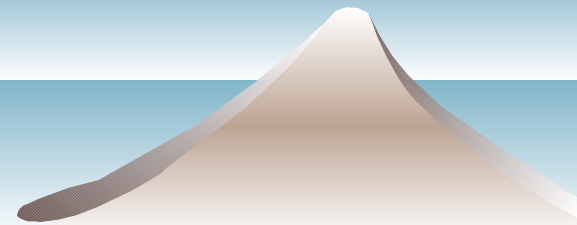
- ▲ But recent emergence of new fast interfaces, USB2.0, IEEE1394 and eSATA, has changed the circumstances.
- ▲ The storage size of HDD increases rapidly year by year with the size per cost (double per year until a few years ago).



- ▲ The media of hard disk is usually not removable, but there is a removable type hard disk and it is composed of “disk drive” and “disk media”.
- ▲ It was the most popular removable R/W media in USA.

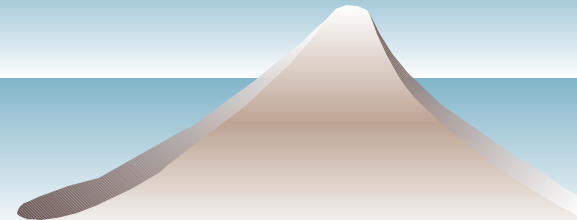


- ▲ Now portable HDD's are popular in Japan as large-sized removable media.
- ▲ As a removable storage, the portable and removable hard disk is the fastest in data transmission but the cost of media (per bytes) is highest other than flash memories.

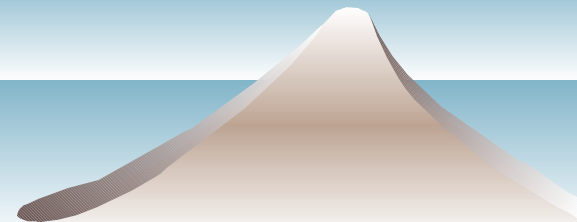


2) CD-ROM (CD-R, CD-RW)

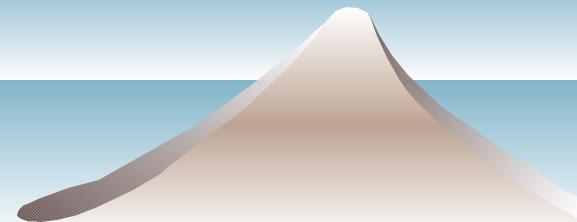
- ▲ CD-ROM is the most popular R/O removable storage of 640MB and size of 12cm.
- ▲ There also media of 8cm and capacity 180MB exist.



- ▲ CD-R is a recordable (only once) type of CD-ROM by CD-R drives and is acceptable by almost all CD-ROM drives.
- ▲ The cost per capacity is the cheapest, though the content can never be changed.



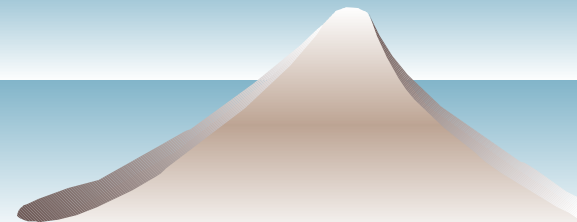
- ▲ CD-RW is a medium which allows repeated recording after erasing the contents.
- ▲ Before, it was accepted only by CD-RW drive, but is becoming acceptable (readable) by new models of CD-ROM (or DVD-ROM) drive.



- ▲ The reading speed of the drive increases year by year and now has reached 52-ple speed.
- ▲ Now all CD-R drive except old models can write CD-RW and writing speed is also increasing year by year, and 52-ple speed for CD-R now.
- ▲ The speed for writing CD-RW is usually slower than CD-R (32-ple).

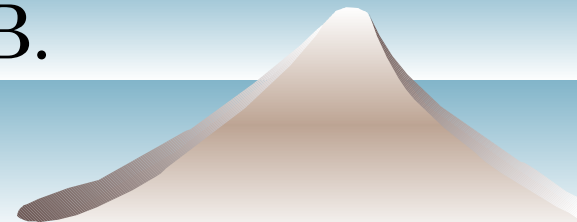


- ▲ Some models can work as DVD-ROM drives stated below.
- ▲ Recently, the speed race of CD-RW is almost finished and the race is moving to DVD-drives.
- ▲ It means that the position of the drive which accept only CD is being replaced by DVD-drives.

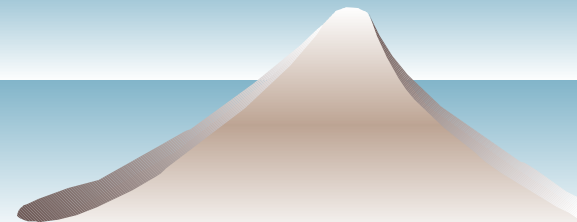


3) DVD-ROM, DVD-R, DVD-RW, DVD+R, DVD+RW, DVD-RAM

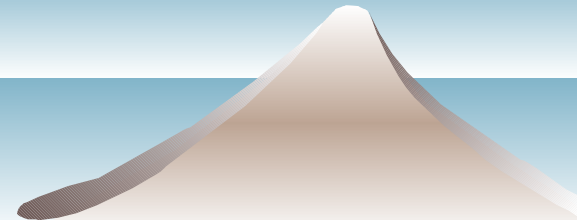
- ▲ DVD-ROM is a new CD-like R/O medium of larger storage capacity.
- ▲ The capacity differs depending on the structure of media:
 - single-layer single-side 4.7GB,
 - single-layer double-side 9.4GB
 - double-layer single-side 8.5 GB
 - double-layer double-side 17GB.



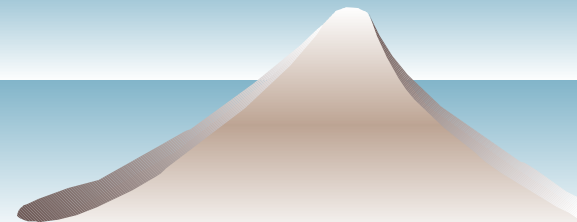
- ▲ The media size is 12cm.
- ▲ There exist 8cm media for special use (DVD-movie).
- ▲ All DVD-ROM drives can read CD-R/RW and some can write CD-R/RW.
- ▲ Most of (all of new) DVD-ROM drives can read recordable DVD media stated below except DVD-RAM, but some model can also read DVD-RAM.



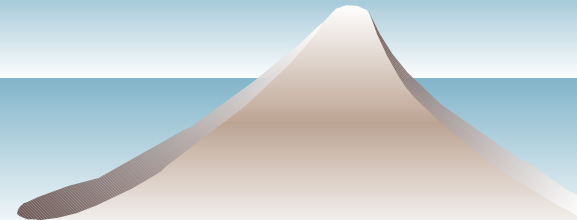
- ▲ DVD-R, DVD-RW, DVD+R, DVD+RW and DVD-RAM are the recordable versions of DVD-ROM and each has its own characteristics.
- ▲ Before, the drive for each media does not have compatibility among each other except all the drives can read DVD-ROM and DVD-R media.



- ▲ Later, various type of drive emerged which accept different media, DVD-R/RAM, DVD-R/RW/RAM, DVD±R/RW drives for example.
- ▲ The emergence of the drive which accept all above DVD media is delayed until 2003.



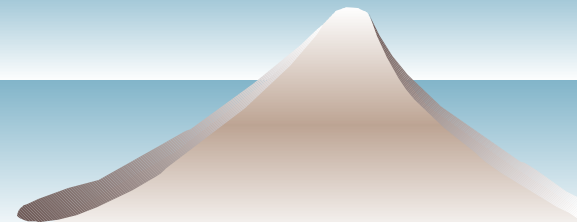
- ▲ Unique terminology of DVD drives
 - a *DVD-multi* drive supports DVD-R/RW/RAM
 - a *DVD-supermulti* drive supports DVD-R/RW/+R/+RW/RAM
- ▲ Now they are in a speed race like CD-RW.
- ▲ Many of the writable DVD drives can write CD-R/RW.



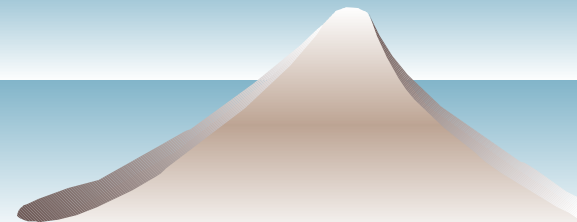
- ▲ DVD supports the double layer and two-sided structures and double-layered DVD-ROM disks exists.
- ▲ The media and the (writable) drives for DVD+R and DVD-R of double layer appeared recently.
- ▲ Most of “DVD-supermulti drive” of new model accept these double-layered discs (DVD-hypermulti drive).



- ▲ Among them only DVD-RAM has the characteristics of free access (read and write) like floppy disks with highest reliability.
- ▲ The cost per storage size of media is the smallest among all removable media of free access.
- ▲ It is directly supported by Microsoft Windows without any additional software.

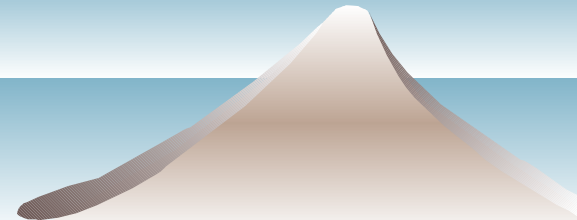


- ▲ But the DVD-RAM disk is not readable by most of DVD-ROM drives while the readability of other DVD disks by DVD-ROM drives is high.
- ▲ Recordable DVD media is also used for recording videos by DVD-recorders and is replacing video-tapes.

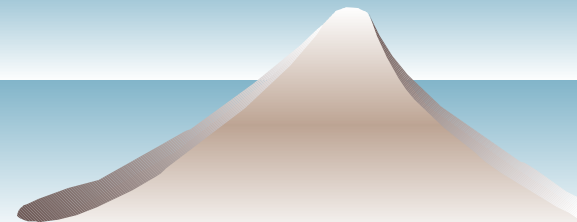


4) Blue-ray Disk (BD)

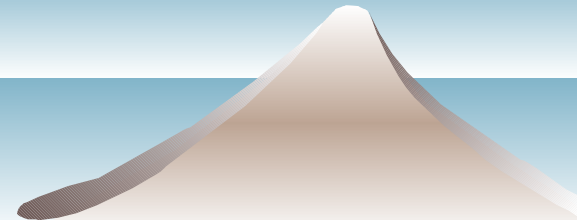
- ▲ This disk is the latest rewritable media of size 12cm which uses a laser light of shorter wave-length (blue ray).
- ▲ It has the larger storage size (23 and 25GB for single layer and 50GB for double layer BD).



- ▲ This media and drives are used for BD-recorders to record videos (of HDTV).
- ▲ BD as a computer storage media is less popular but BD drives for PC's and computers with a BD-drive are sold.

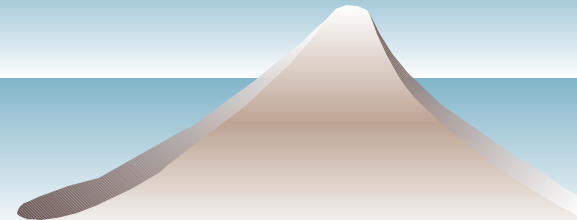


- ▲ Though the competition with HD DVD as the storage media of video had been the anxiety for popularization of BD, recent withdrawal of Toshiba company from HD DVD may remove the problem.

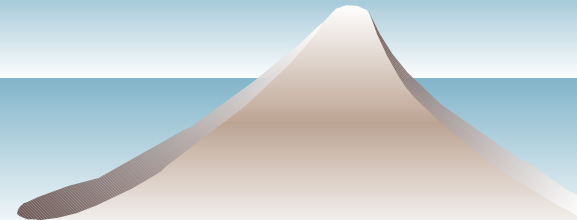


5) Flash Memory

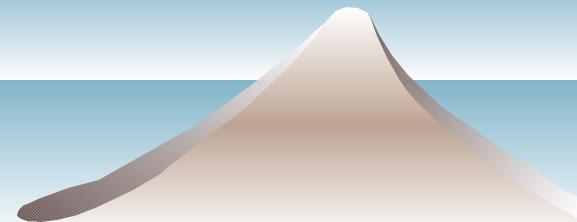
- ▲ This is a special type of IC memory which can keep its memory content without electric power supply.
- ▲ The storage size reach GB recently.
- ▲ Although the cost per storage size is high, its usage spreads rapidly because of the smallness of their physical sizes.



- ▲ There are rather many types (shapes) of flash memories as shown below.
- ▲ Different drives (called memory card reader/writers) are needed to handle them.
- ▲ The reader/writers are usually connected to USB and some of them can accept flash memories of various type.



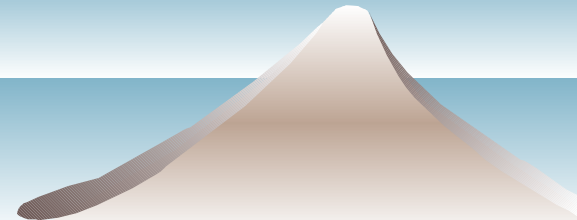
- ▲ There also exists adapters to use them in PCMCIA sockets.
- ▲ The development of flash memory comes with that of digital cameras, because many of below are used as the “film” of digital cameras.



- (1) smart media
- (2) compact flash
- (3) micro drive

(not a flash memory but a hard disk media of compact flash size)

- (4) multimedia card, reduced size MMC
- (5) SD(SDHC) memory card
- (6) mini-SD card



(7) micro-SD card

(8) memory stick, memory stick PRO

(9) memory stick Duo, memory stick
PRO Duo

(10) xD-picture card

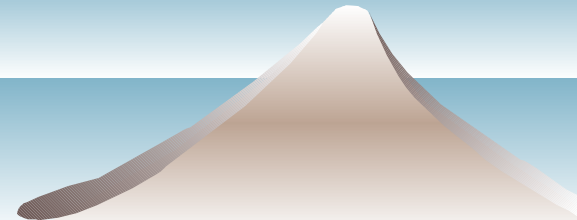
(11) PCMCIA flash

(12) USB memory (flash memory
directly connectable to USB socket)

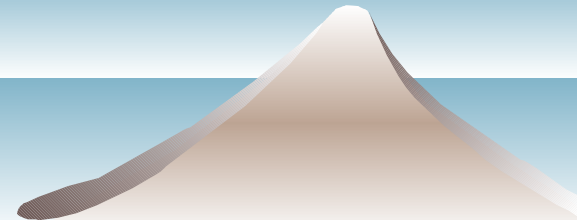


6) Floppy disk

- ▲ Floppy disks, though they were widely used in spite of the smallness of the storage size and the data transmission speed.
- ▲ The recent develop of flash memories has expelled them.

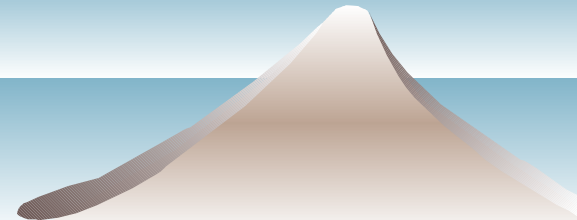


- ▲ Many PC's sold now are not equipped with FD drives.
- ▲ Instead, the external floppy-disk drives (of double speed) for USB interface are sold.
- ▲ Some of them accept super floppy disks and some can store 32MB in a usual floppy media.

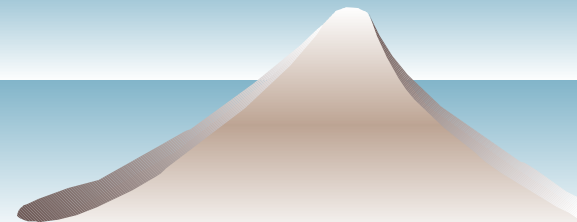


7) MO (Magnet-Optical) disk

- ▲ There are two types of MO disk in size, 5.25 inch and 3.5 inch.
- ▲ The former has large storage capacity and both drives and media are very expensive.
- ▲ It is usually used for Workstations and is not popular for PC's.



- ▲ The 3.5 inch MO disk is the most popular R/W removable storage in Japan and cost per storage size is relatively low.
- ▲ There are 5 types of storage capacity of MO disks and drives: 128MB, 230MB, 640MB, 1.3GB and 2.6GB.
- ▲ A drive for disks of a capacity can also accept disks of lower capacity.



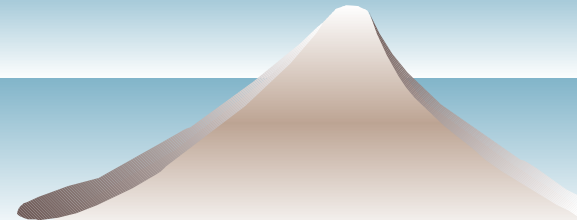
8) ZIP disk

- ▲ This is a floppy-disk like media of capacity 128 and 250MB.
- ▲ The advantage of ZIP are fairly fast speed and cheapness of the drive, but the cost per capacity of the media is much higher than MO and the drive can not accept floppy disks.
- ▲ This media is (or was) relatively popular in USA, but we seldom find this in Japan recently.



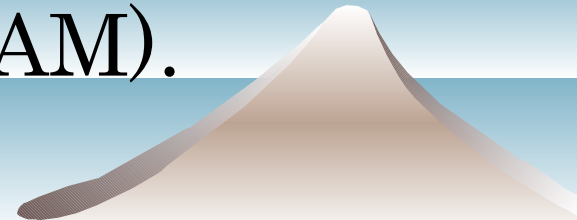
9) Super Floppy disk

- ▲ This is also a floppy-disk like media of capacity 120MB.
- ▲ The advantage of the drive is that it can accept usual floppy-disks.
- ▲ The cost of drive and media is almost same as ZIP, but the speed is slower.
- ▲ This media was mainly used in Japan, but not popular now.



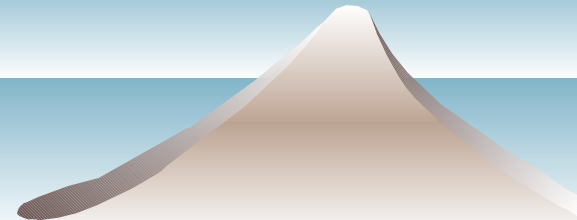
10) PD disk

- ▲ This is another type of optical disk. The media size and capacity is as large as CD-ROM but contained in a case. The drive can read CD-ROM.
- ▲ The drive and media is cheaper than MO, but the speed is slower and size is larger. Though we can seldom find this media now, what is noted is that the technology of this disk has developed to that of DVD(-RAM).



11) Hi-MD

- ▲ MD(Mini-Disc) was used only for recording sounds.
- ▲ Hi-MD is a new media which can store longer-time sound adopting the new data format (Hi-MD format).
- ▲ This format can also be applied to a usual (non-Hi) MD which makes it possible to store the sound of double time or more.



- ▲ Though not popular at all, what is interesting is computer data can be stored in Hi-MD and usual MD formatted in Hi-MD format.
- ▲ The storage capacities are:
 - Hi-MD 1GB
 - 80min. MD 305MB
 - 74min. MD 282MB
- ▲ Some models of portable Hi-MD recorder have USB interface to support this function.

