RECONSTRUCCIÓN DE PALEOINUNDACIONES

Cálculo de la frecuencia y de la magnitud de inundaciones

Método directo: registro instrumental del caudal

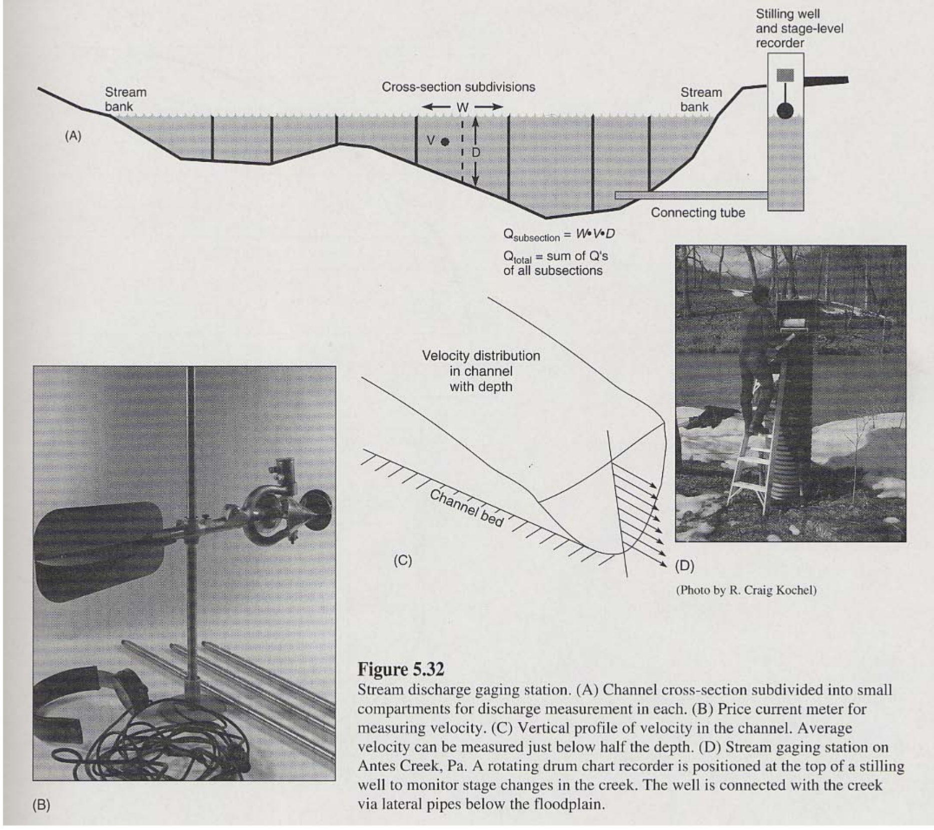


Figure 5.32
Stream discharge gaging station. (A) Channel cross-section subdivided into small compartments for discharge measurement in each. (B) Price current meter for measuring velocity. (C) Vertical profile of velocity in the channel. Average velocity can be measured just below half the depth. (D) Stream gaging station on Antes Creek, Pa. A rotating drum chart recorder is positioned at the top of a stilling well to monitor stage changes in the creek. The well is connected with the creek via lateral pipes below the floodplain.

Registro de caudal suficientemente largo (> 30 años):
Análisis estadístico (valores máximos/extremos)

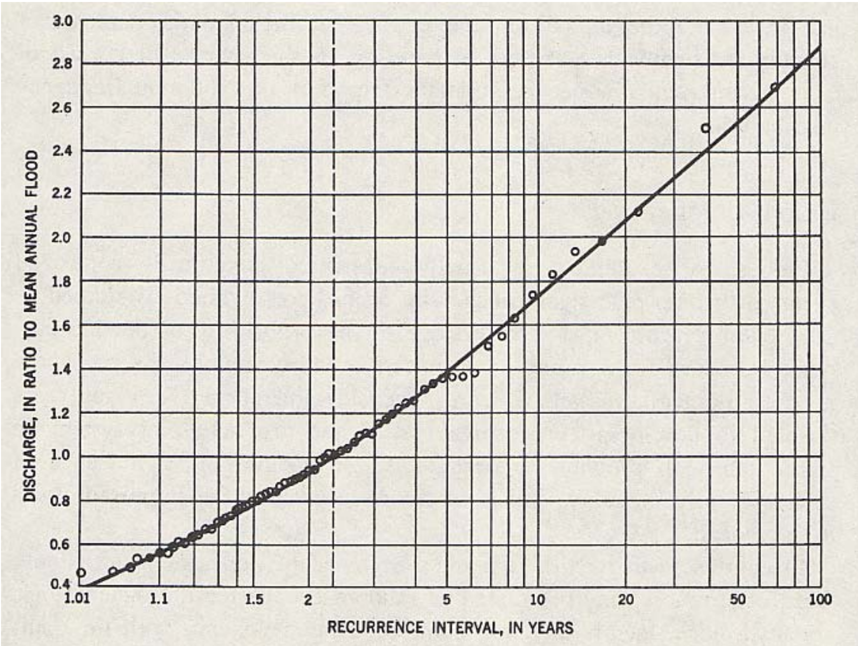


Figure 3-14. *Regional flood-frequency curve for Youghiogheny and Kiskiminetas river basins, Pennsylvania. To determine the recurrence interval of a particular flood flow at point, the mean annual flood at that point is measured or estimated; the ratio of the flood flow to the annual flood is then entered on the ordinate and the recurrence interval of the flood is read on the abscissa.*

Problemas (1):

Valores anómalos (p. ej.: intervalo de observación de 40 años pero ocurrencia de una inundación excepcional)

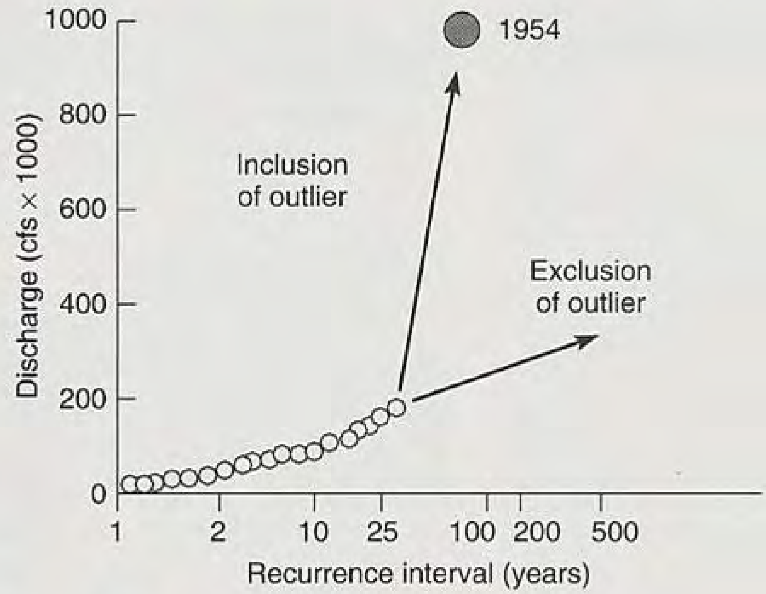


Figure 5.35
Flood frequency curve for the Pecos River near Langtry, Texas. Note the extreme outlier representing the 1954 flood and the problem for environmental planners of how to interpret this point.

Problemas (2):

Estadística válida para serie estacionaria de caudales (media y varianza constantes). ¿Han ocurrido cambios en el clima a escala decenal?

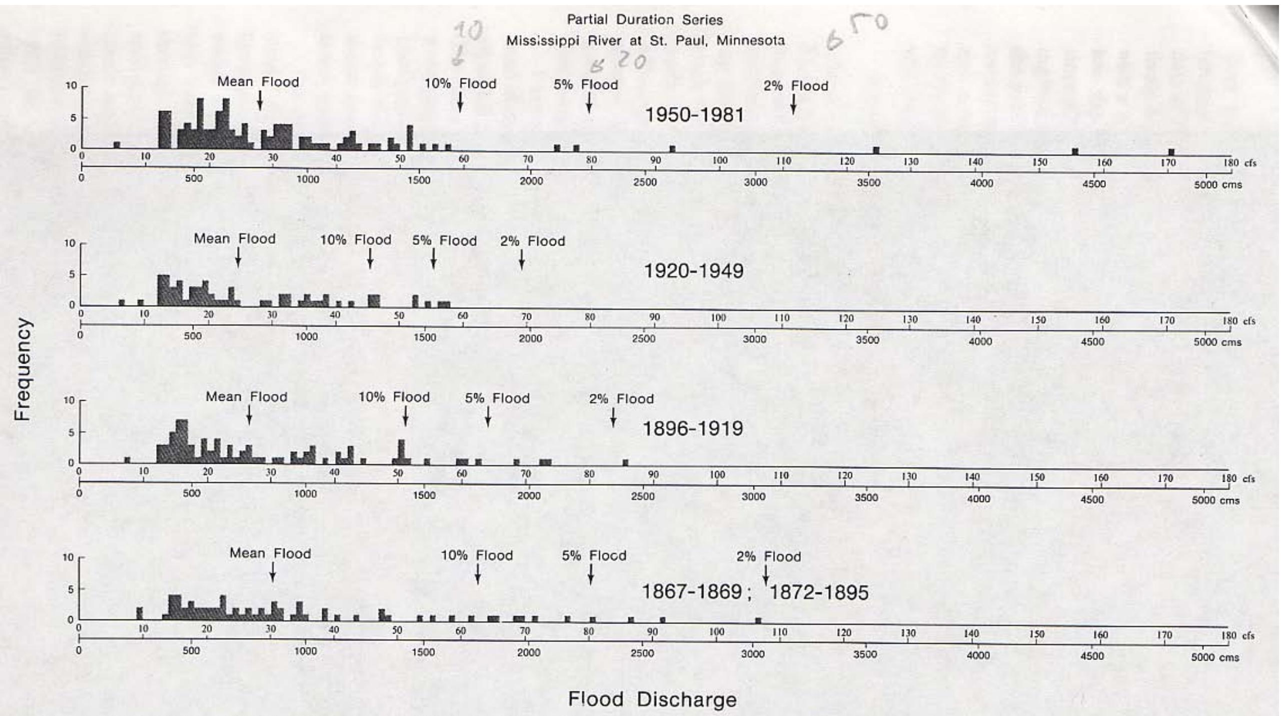


Fig. 1. Histograms of partial duration series Mississippi River floods at St. Paul, Minnesota. Four independently determined climate episodes are recognized with series boundaries at about 1895, 1920, and 1950

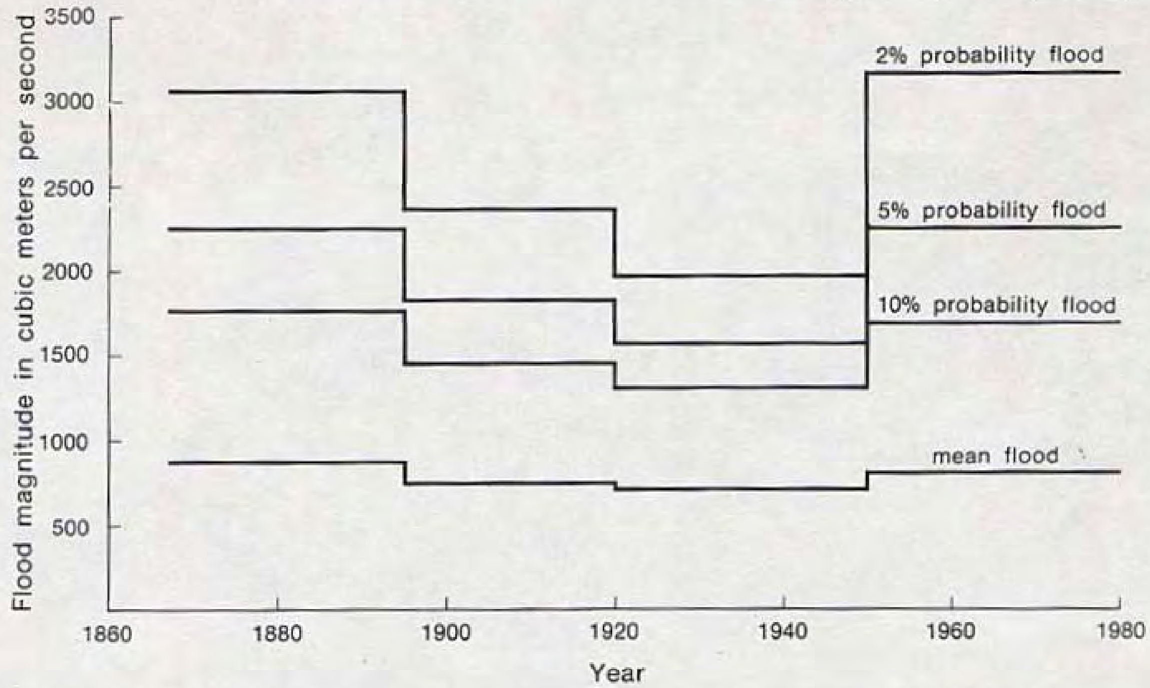


Fig. 2. Climatic influence on magnitudes of floods of a given recurrence probability. Data are the same as those of Fig. 1

Problemas (3):

SIMPLEMENTE NO HAY REGISTRO DE CAUDALES DONDE NOS INTERESA

¿Hay datos de precipitación disponibles?:

- ✓ **Métodos hidrometeorológicos (precipitación-escorrentía-caudal) p.ej:**
  - **Método racional (Témez)**
  - **Hidrograma unitario**

Problemas:

- **Series de precipitación cortas (pocos años), extrapolación poco fiable**
- **No hay datos de precipitación disponibles**

¿Registro histórico de inundaciones?

- **Frecuencia sí (datos de los últimos 500 años en archivos históricos)**
- **Magnitud no (no caudal, ocasionalmente altura de agua)**

Estimación de la frecuencia y de la magnitud de inundaciones a partir de datos geológicos (hidrología de paleoinundaciones)

¿Edad de las avenidas?
- recientes (días) hasta antiguas (varios miles de años)

La mayoría de estudios: últimos 5000 años

Fundamentos

Reconstrucción de una crecida

1) **Existencia de indicadores geomorfológicos de inundaciones (marcas de nivel de crecida un río): altura de la crecida**
   - **Daños a la vegetación (heridas de impacto en árboles)**
   - **Pátinas de arcillas y limos en árboles, etc (inundaciones recientes)**
   - **Escarpes erosionales**
   - **Depósitos de inundación**

2) **Correlación de marcas de nivel de una inundación a lo largo del valle: perfil longitudinal del nivel de la crecida**

3) **Datación**

4) **Estimación del caudal máximo de la crecida:**
   - **Altura de agua: área sección transversal**
   - **Determinación de la velocidad de la corriente por métodos hidráulicos (Chezy, Manning, area-pendiente, step backwater)**

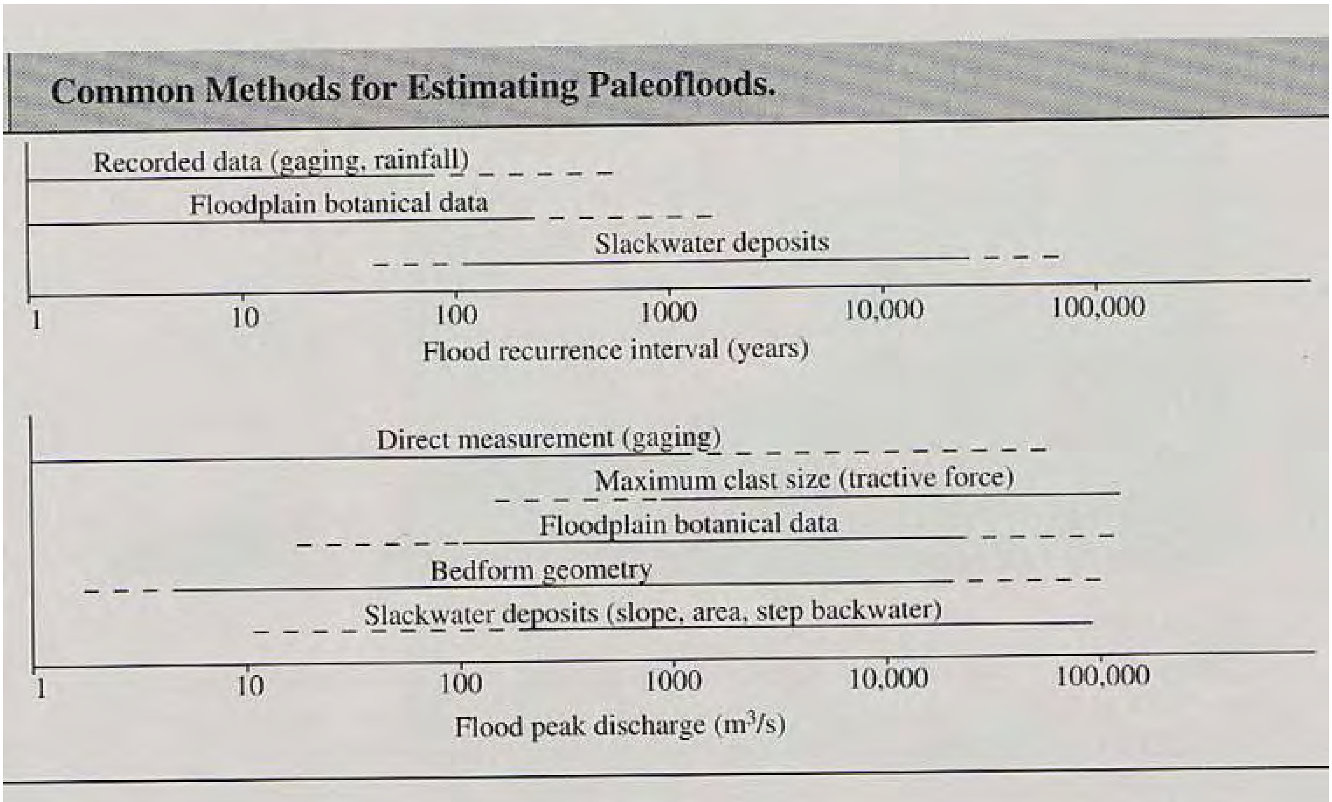
Reconstrucción de una serie de crecidas

1) Identificación de marcas de nivel de diferentes crecidas (nº de inundaciones). Ej: depósitos de inundación a diferentes cotas

2) Distinción y correlación de las marcas de nivel de cada crecida a lo largo del valle: perfil longitudinal del nivel de la crecida

3) Datación

4) Estimación del caudal máximo de cada inundación



Depósitos “slackwater”

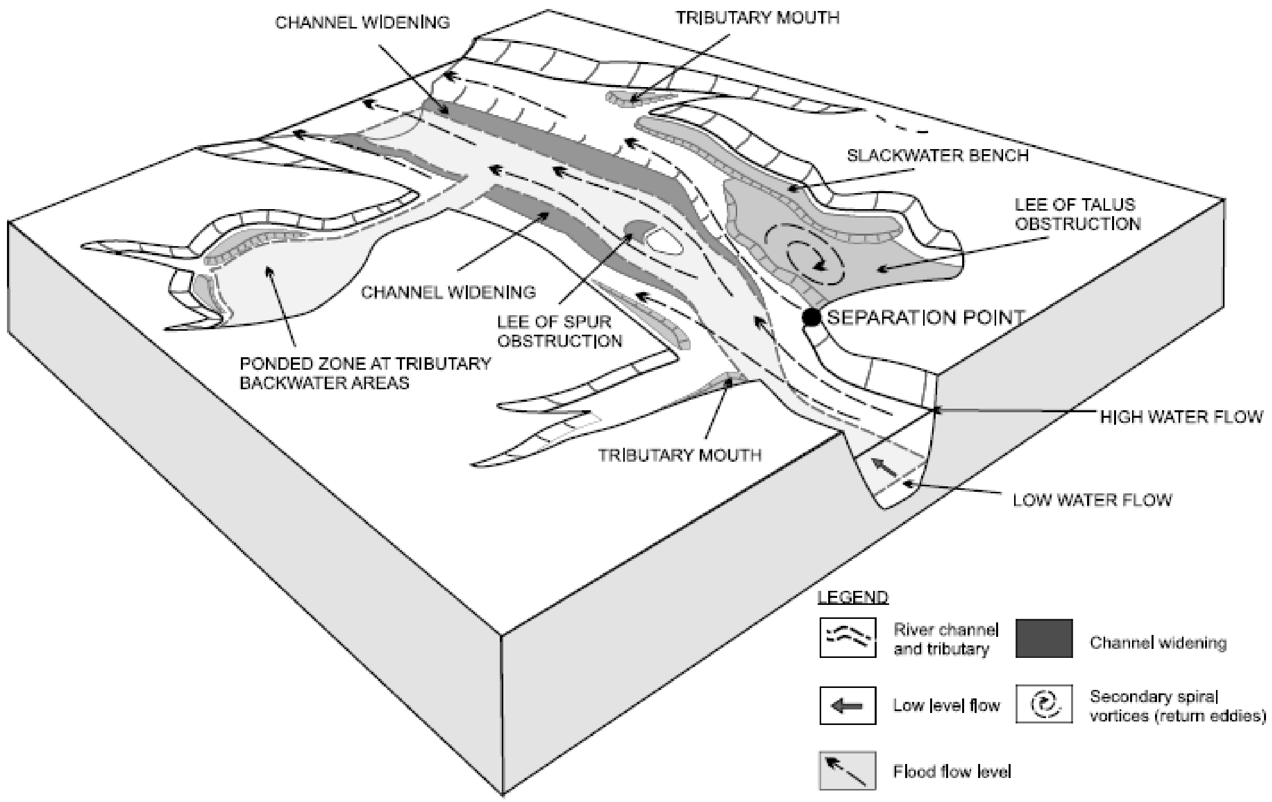
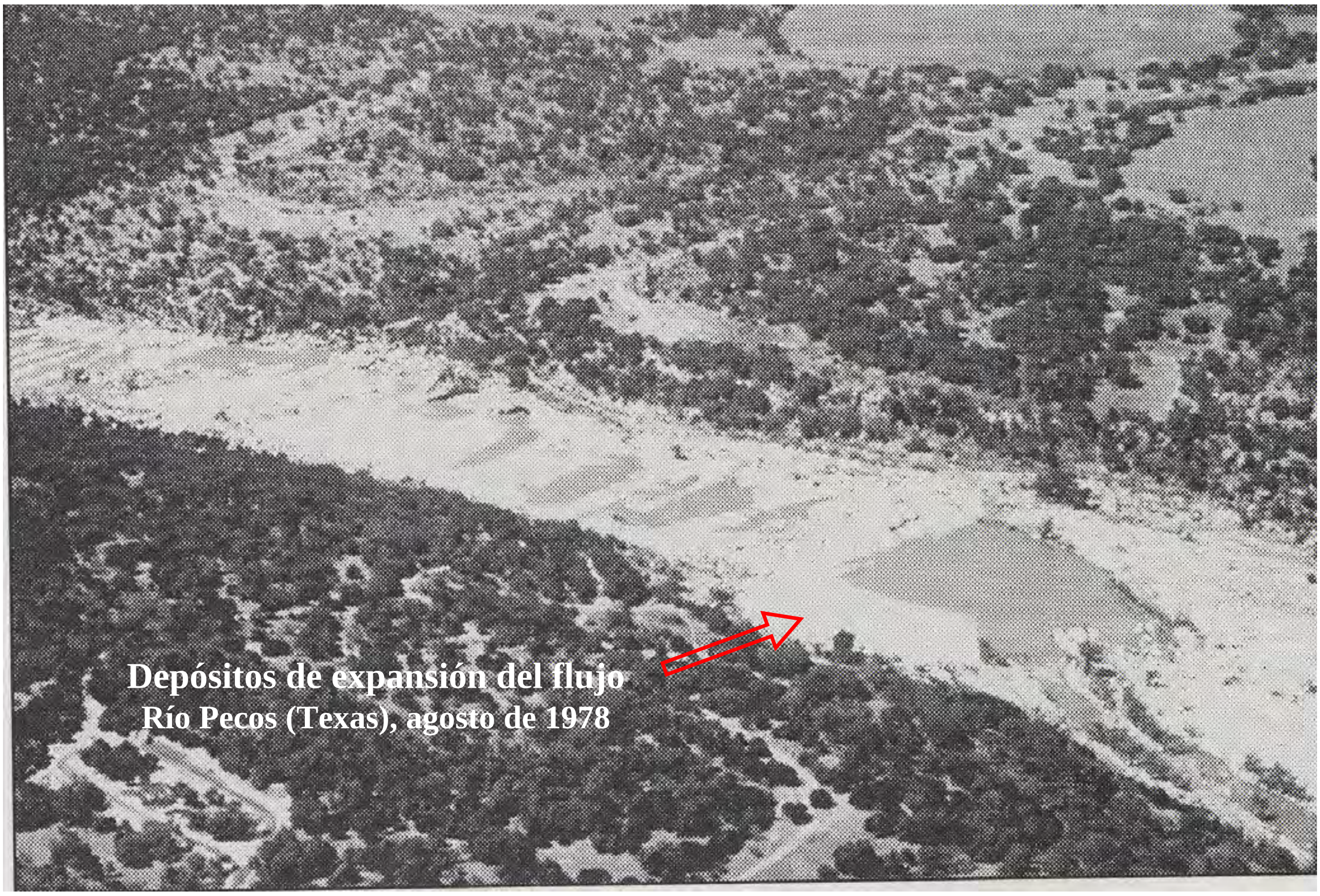


Fig. 1. Block diagram displaying the location of sedimentary environments related to flood deposition (modified from Benito et al., 2003b).

Inundación invasiva de tributarios (Río Pecos, Texas, agosto de 1978)



Depósitos “slackwater” en abrigos rocosos

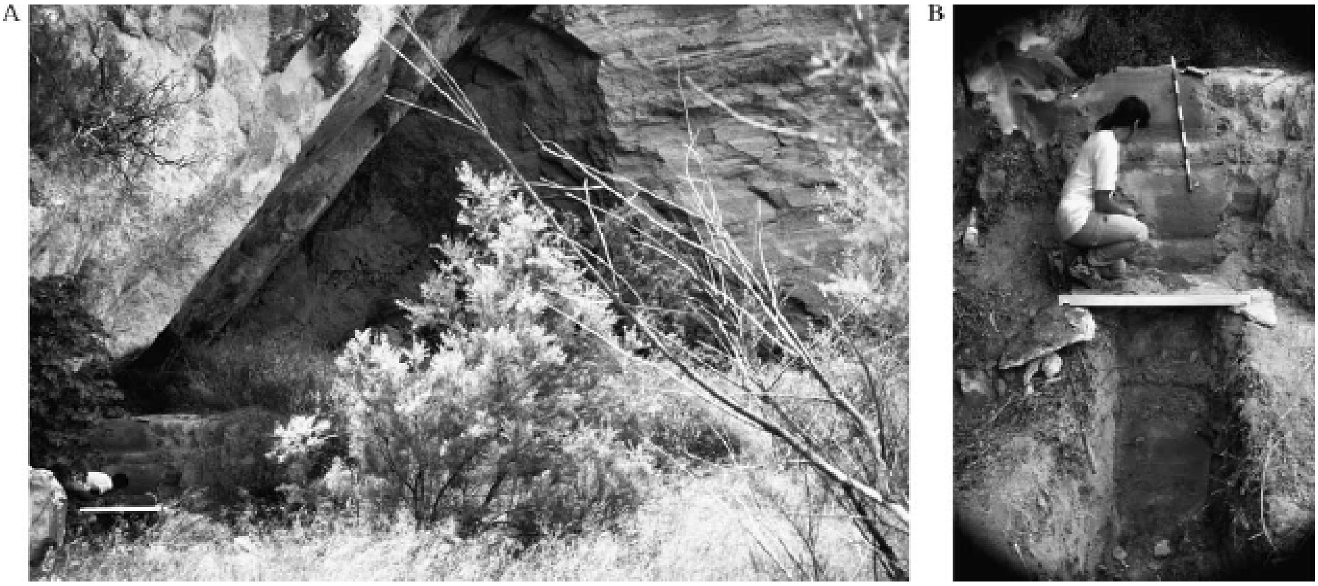
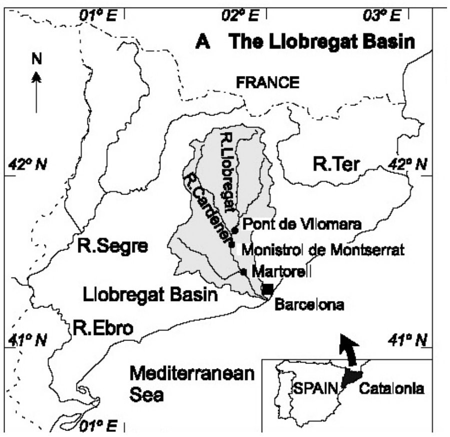


Fig. 2. A: Photo illustrating a rock shelter site of slackwater deposition in the valley of the ephemeral Guadalentín River, SE Spain. The slackwater flood deposits can be seen in the bottom left corner and in Photo B.

Depósitos "slackwater" en abrigos rocosos:

- **ventajas de trabajar en cauces fijos**
- **depósitos más protegidos de la erosión por crecidas posteriores, o por deslizamientos**
- **depósitos más protegidos de la bioturbación**



Cuenca del Llobregat

- **9 inundaciones durante el siglo XX**
- **Q <3100 m^3/s (en Martorell)**

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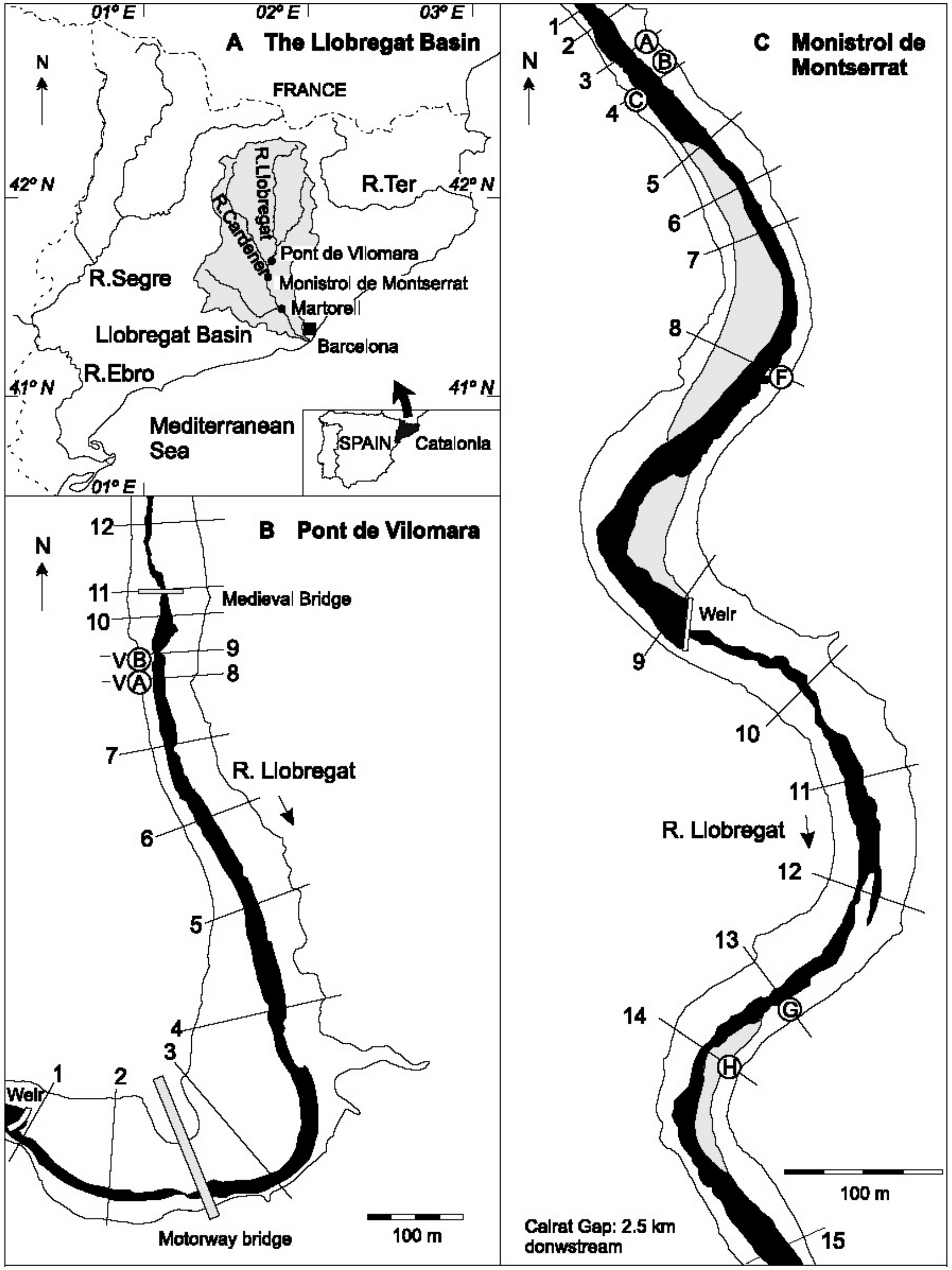
Table 1
Peak discharges of the major 20th century floods

Year	Date	Peak Q (m^3/s) at Martorell (4561 km^2)	Fatalities and economic losses (Llasat et al., 2001)
1907	October 7th	1500[a], 2875[b]	–
1913	September 29th	1540[c]	–
1919	October 7th	1500[c]	–
1940	October 18th	2200[a]	–
1942	October 28th	1500[a]	–
1962	September 25th	1550[c]	441 deaths €15.9 m
1971	September 20th	3080[c]	9 deaths €42.1 m
1982	November 6th	1600[c]	6 deaths €270.5 m
2000	June 10th	1100[d]	5 deaths €66.1 m

[a] Peak discharge estimated by Junta d'Aigües (1994).
[b] Peak discharge cited in Solé Sabarís (1958).
[c] Peak discharge recorded at the Martorell gauging station.
[d] Peak discharge recorded at Castellvell as the Martorell gauging station was damaged during this event (Llasat et al., 2001).

Selección de perfiles transversales más adecuados:

- **Tramos de valle estrecho**
- **Evitar meandros en el valle (sobreelevación)**
- **Evitar obstáculos que puedan causar alteraciones de la corriente (p. ej. puentes – medievales-)**
- **Búsqueda de abrigos rocosos**
- **Perfiles topográficos tranversales a la corriente de avenida**



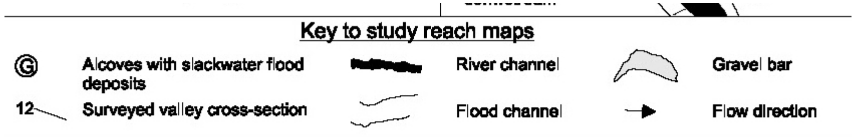


Fig. 1. Location of the Llobregat Basin in NE Spain (A). The Pont de Vilomara (B) and Monistrol de Montserrat (C) study reaches, illustrating the location of rock alcoves preserving slackwater flood deposits (sites A–H) and surveyed cross sections (numbered).

Distinción de depósitos de diferentes inundaciones

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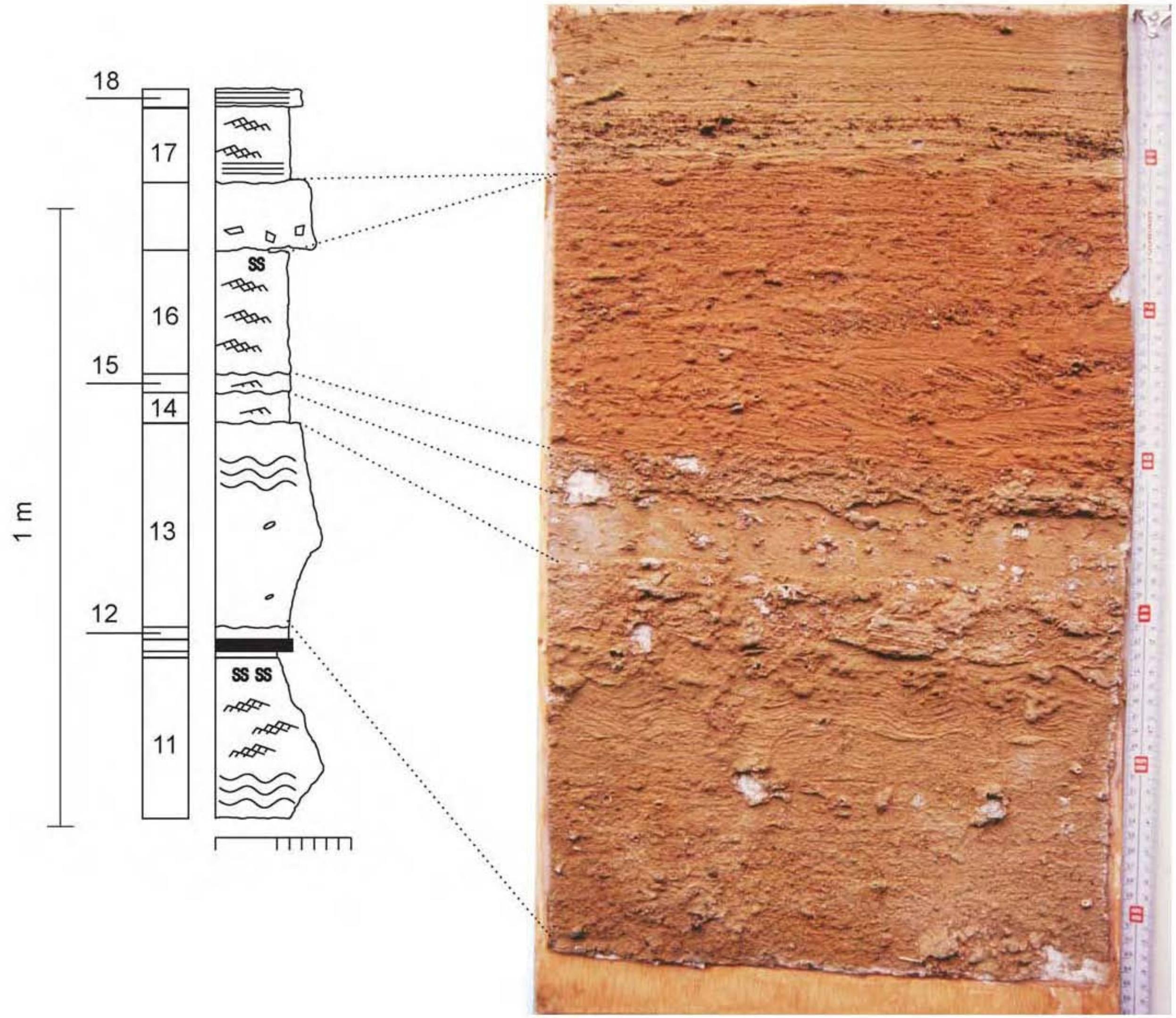
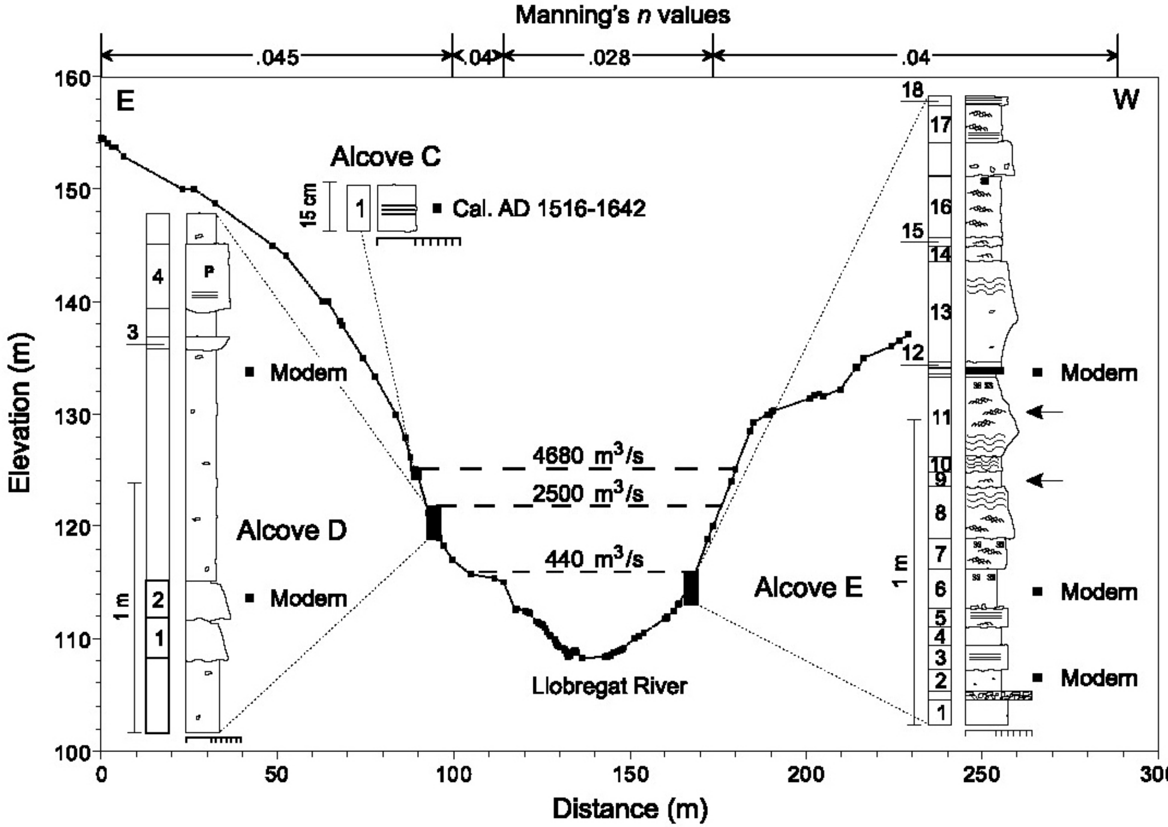


Fig. 2. Sediment lacquer peel and stratigraphic column from the upper flood units of Alcove E (see Fig. 3 for complete stratigraphy and key). The photo of the peel shows the contacts between the distinct flood units and the sedimentary structures that provide information on sediment load and flow velocity. NB. Flood unit 18 and the slope deposits between units 16 and 17 appear laterally in the cut trench and pinch out before reaching the back wall of the trench from where the peel was taken.



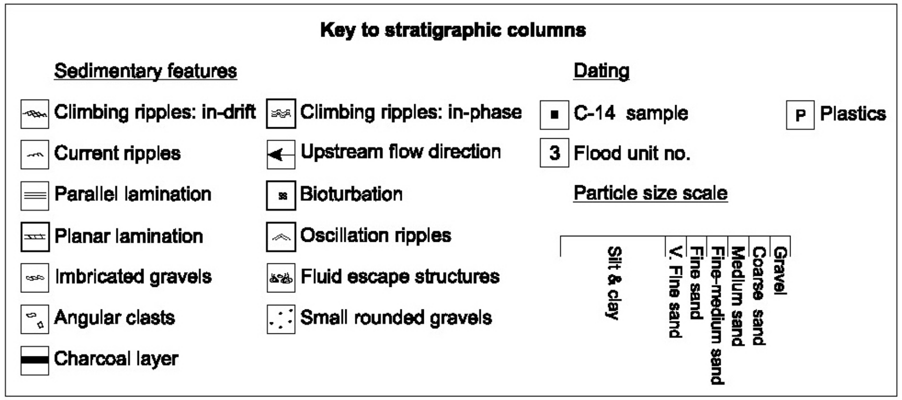


Fig. 3. Amalgamation of cross-sections 3 and 4 of the Monistrol study reach indicating the relative elevations of Alcoves C–E, with the respective stratigraphic columns alongside. The elevation and stratigraphy of the three profiles clearly illustrates the magnitude-frequency relationships of the three alcoves with Alcove E representing a relatively complete record of low to high magnitude flood events over the last ca. 100 years whilst Alcove C just preserves the deposits of one extreme high magnitude low frequency event that occurred in the Little Ice Age. Also indicated are the minimum discharge estimates for the upper flood units of each alcove and the Manning's n values used in the hydraulic model (see Table 4). Below is the key to all the stratigraphic columns (Figs. 2–5).

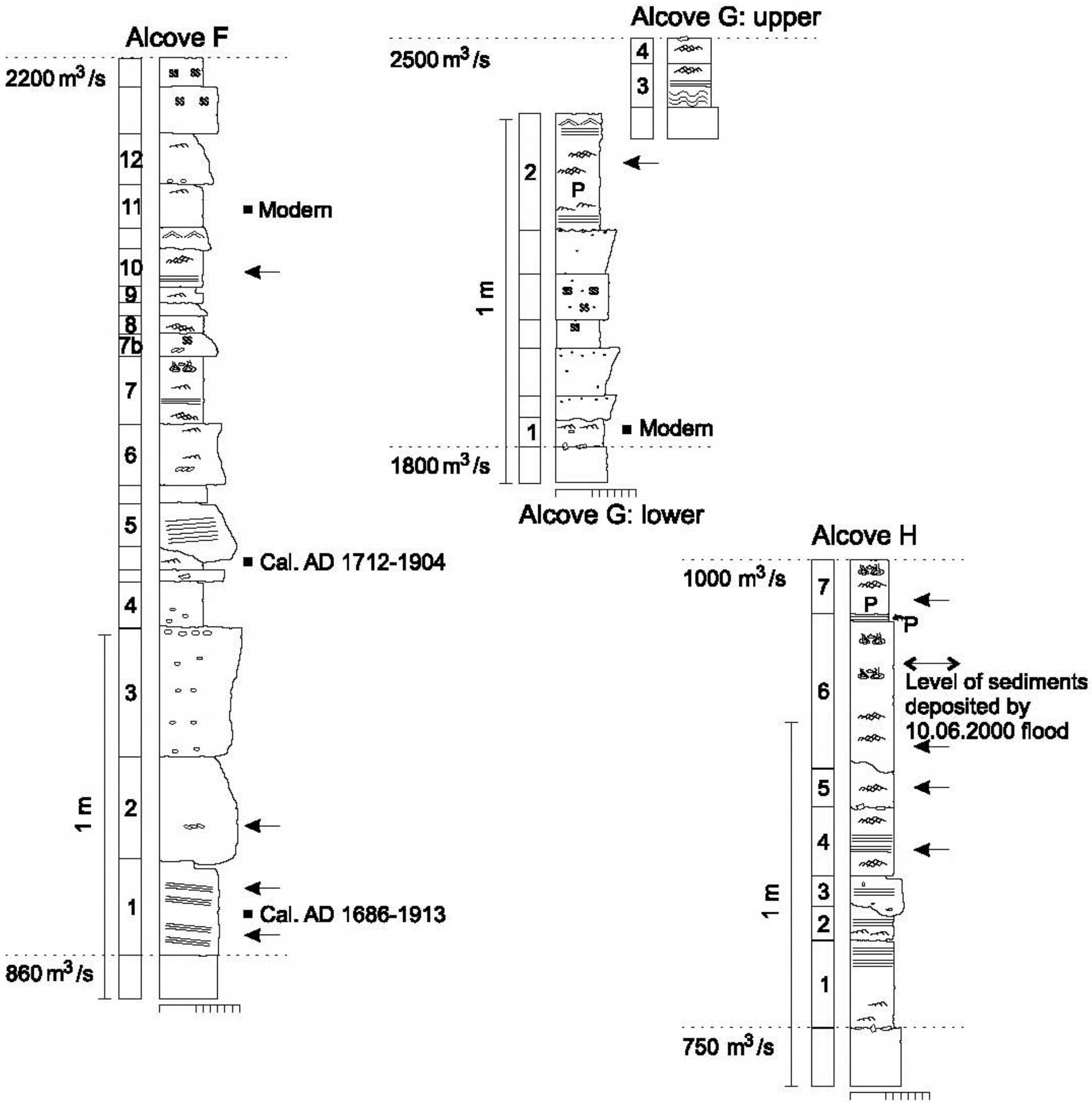


Fig. 4. The stratigraphies of Alcoves F–H of the Monistrol study reach. In Alcove G a small rock shelf at the back of the alcove separates the upper and lower profiles. The flood units are labelled distinctly but may be repeated in the two profiles. Also indicated are the minimum discharge estimates required for the flood waters to reach the base and roof of each alcove. (See Fig. 3 for the key to the stratigraphic columns).

Acreción vertical de los depósitos: registro sedimentario más completo de las inundaciones (pero sólo de inundaciones sucesivamente más importantes)

Indicador de altura mínima de la crecida

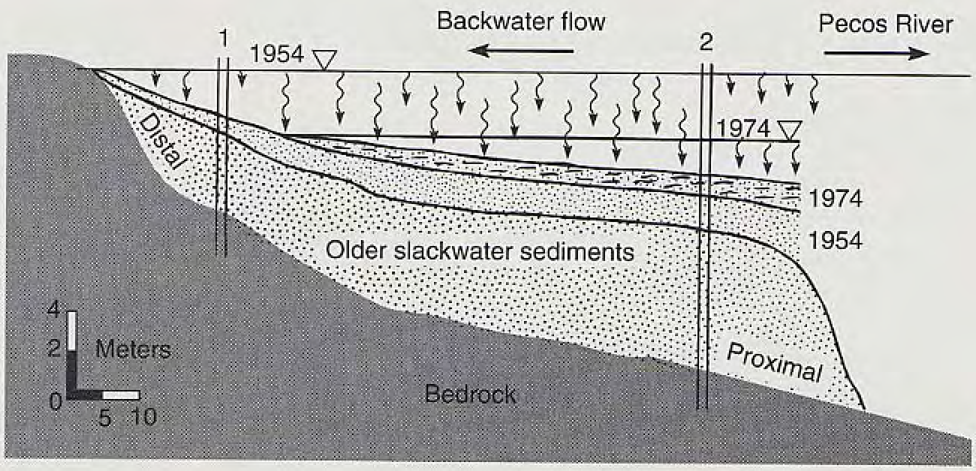


Figure 5.37
Schematic of on- and off-lap sequences and peak flood stage in a tributary valley for the 1954 and 1974 floods on the Pecos River, Texas. Sections in the proximal region (area 2) contain both floods, while distal regions (area 1) farther up the tributary record only the larger 1954 flood. Paleostage reconstructions are based on the elevation of the most distal sediments of each flood unit.
Kochel et al. 1982

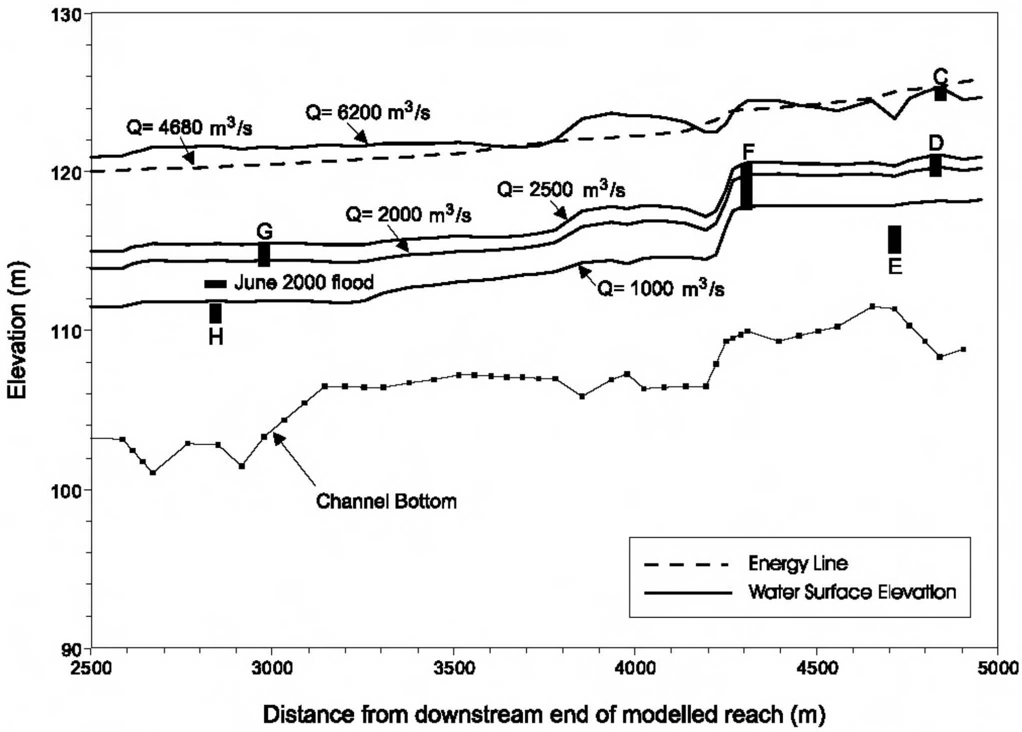


Fig. 6. Calculated water surface and energy line elevations for selected discharges related to the mapped palaeostage indicators (slackwater flood deposits) at Alcoves C–H along the Monistrol study reach. The elevation of debris and silt lines left above Alcove H by the June 2000 flood is also indicated. This data was used to calibrate the hydraulic model at this reach.

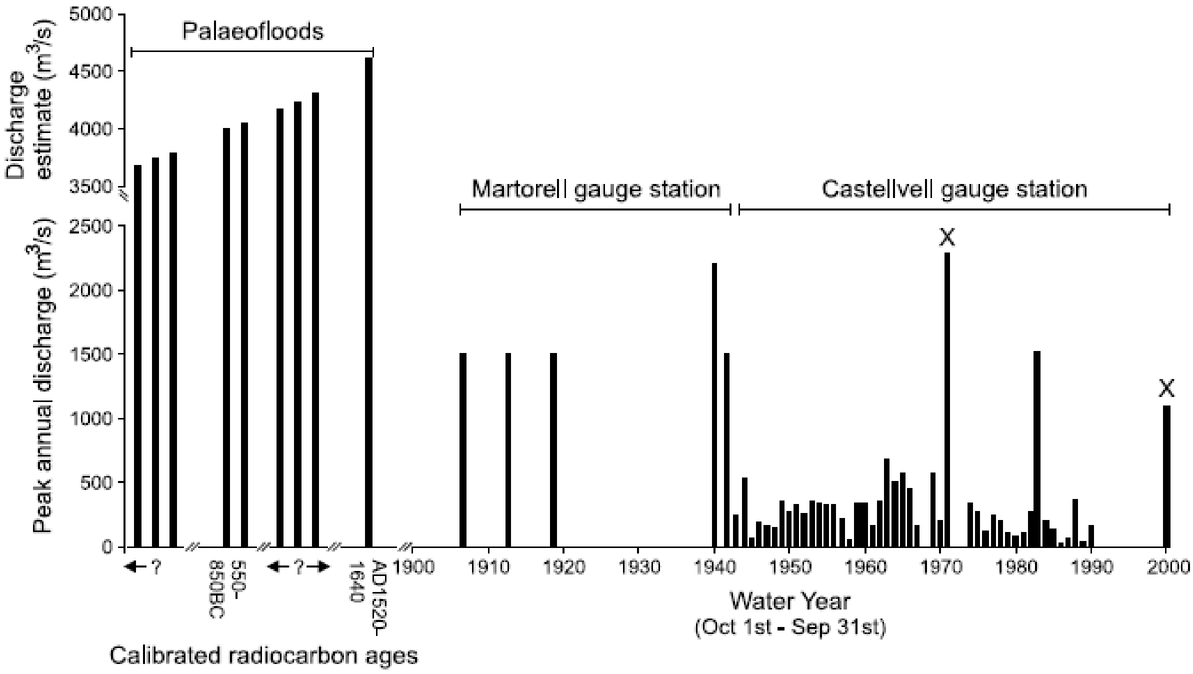


Fig. 3. Flood magnitudes of the Llobregat River illustrating the high discharges associated with the palaeofloods relative to those measured at the gauging stations.

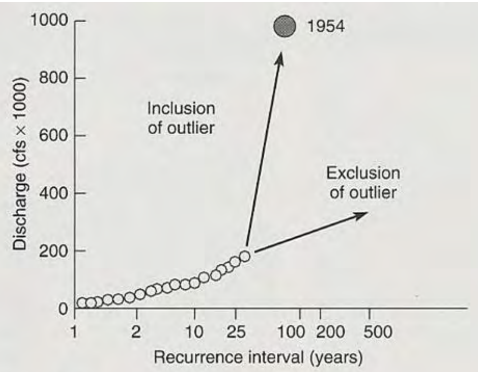


Figure 5.35
Flood frequency curve for the Pecos River near Langtry, Texas. Note the extreme outlier representing the 1954 flood and the problem for environmental planners of how to interpret this point.

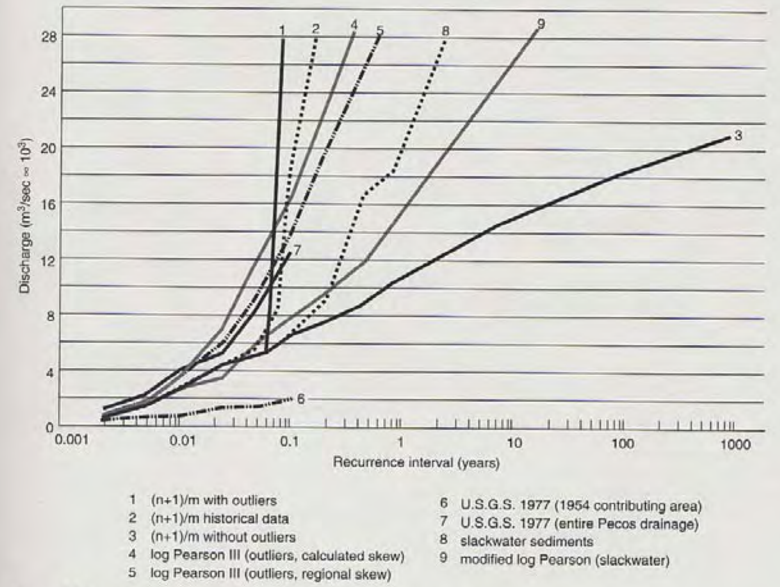


Figure 5.38
Range of potential flood frequency curves calculated using a variety of common standard techniques applied to the Pecos River flow data. Estimates of flood frequency for the 1954 flood outlier range from less than 100 years to more than 20 million years. Slackwater paleoflood deposits were used to provide a more realistic estimate based on physical flood evidence of around 2000 years.
Kochel and Baker 1982