

# **Use of Chlorine-36 and Cl Data to Determine Hydrologic Pathways at Yucca Mountain**

**Presentation to:  
Nuclear Waste Technical Review Board (NWTRB)**

**Presentation by:  
Paul R. Dixon  
Los Alamos National Laboratory**

**J.T. Fabryka-Martin, S.S. Levy and A.V. Wolfsberg  
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**D.S. Sweetkind and A.L. Flint  
U.S. Geological Survey**

**Beatty, Nevada  
June 29-30, 1999**



**U.S. Department of Energy  
Office of Civilian Radioactive  
Waste Management**

**Yucca  
Mountain  
Project**

# Site Investigations at Yucca Mountain



- **Yucca Mountain, Nevada, is under investigation as the potential site for the Nation's first repository for high-level radioactive waste**
- **Understanding flow rates and pathways are critical in assessing the repository's probable performance in isolating wastes from the accessible environment**
- **Fast pathways may be potential seeps under wetter climatic conditions**

# Objectives



- **To constrain conceptual models for UZ flow and transport, based on measurement and simulation of suitable environmental tracers ( $^{36}\text{Cl}$  and  $\text{Cl}$ )**
- **Specific objectives are:**
  - to select appropriate numerical model (equivalent continuum vs dual permeability)
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# Approach



- **Develop extensive data sets of  $^{36}\text{Cl}$  and porewater Cl concentrations for the UZ (ESF, Cross Drift, surface-based boreholes)**
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- **Constrain conceptual models, by a team of hydrologists, structural geologists, mineralogists, and flow and transport modelers**
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# Chlorine-36 as a Hydrologic Tracer



- **Cl-36 Half-Life = 301,000 Years**
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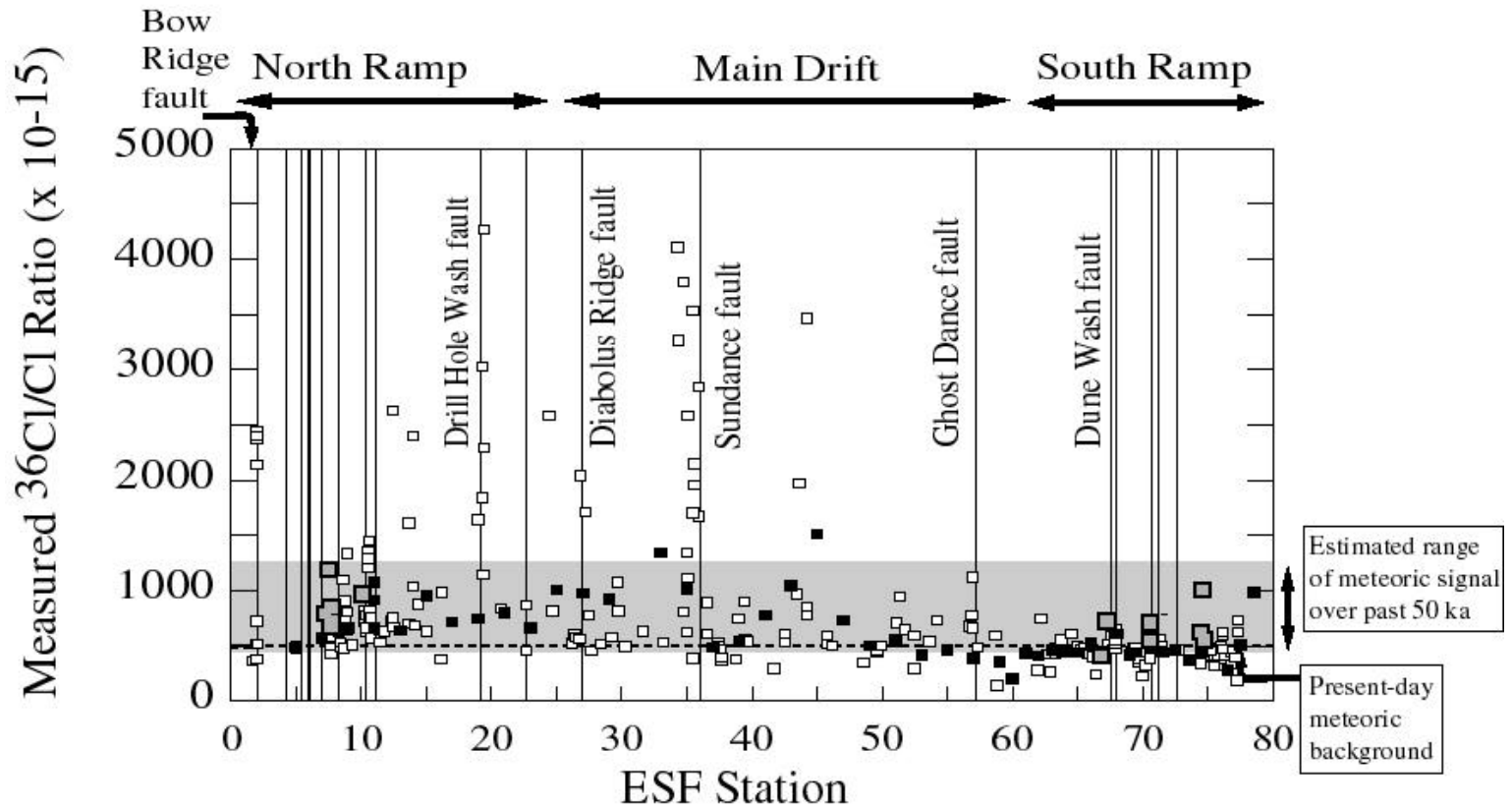
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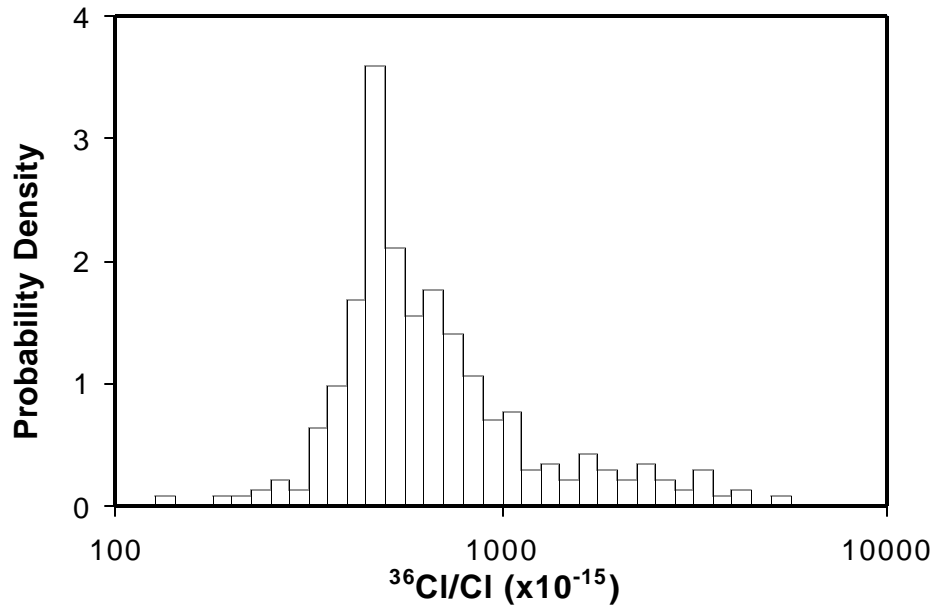
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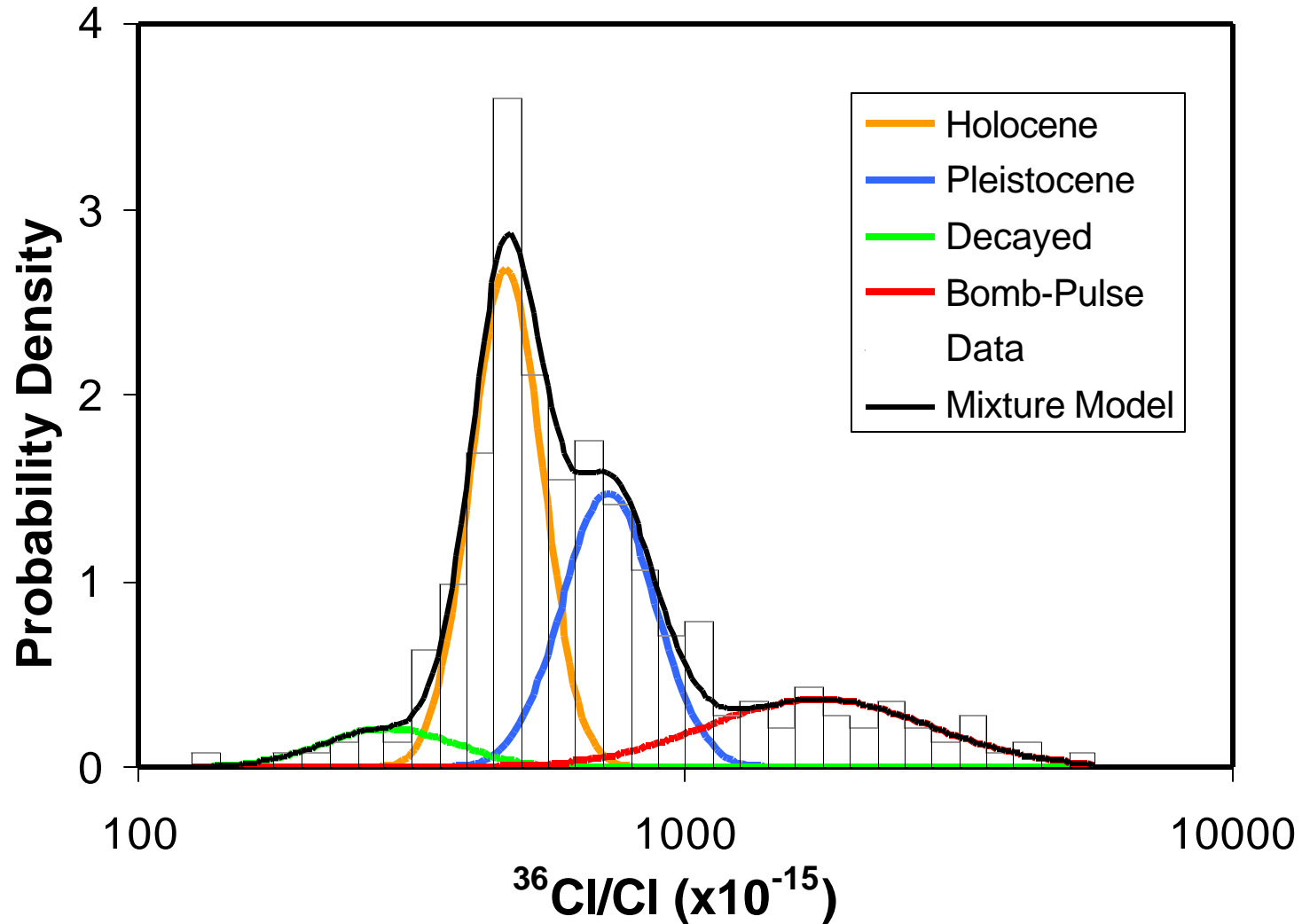


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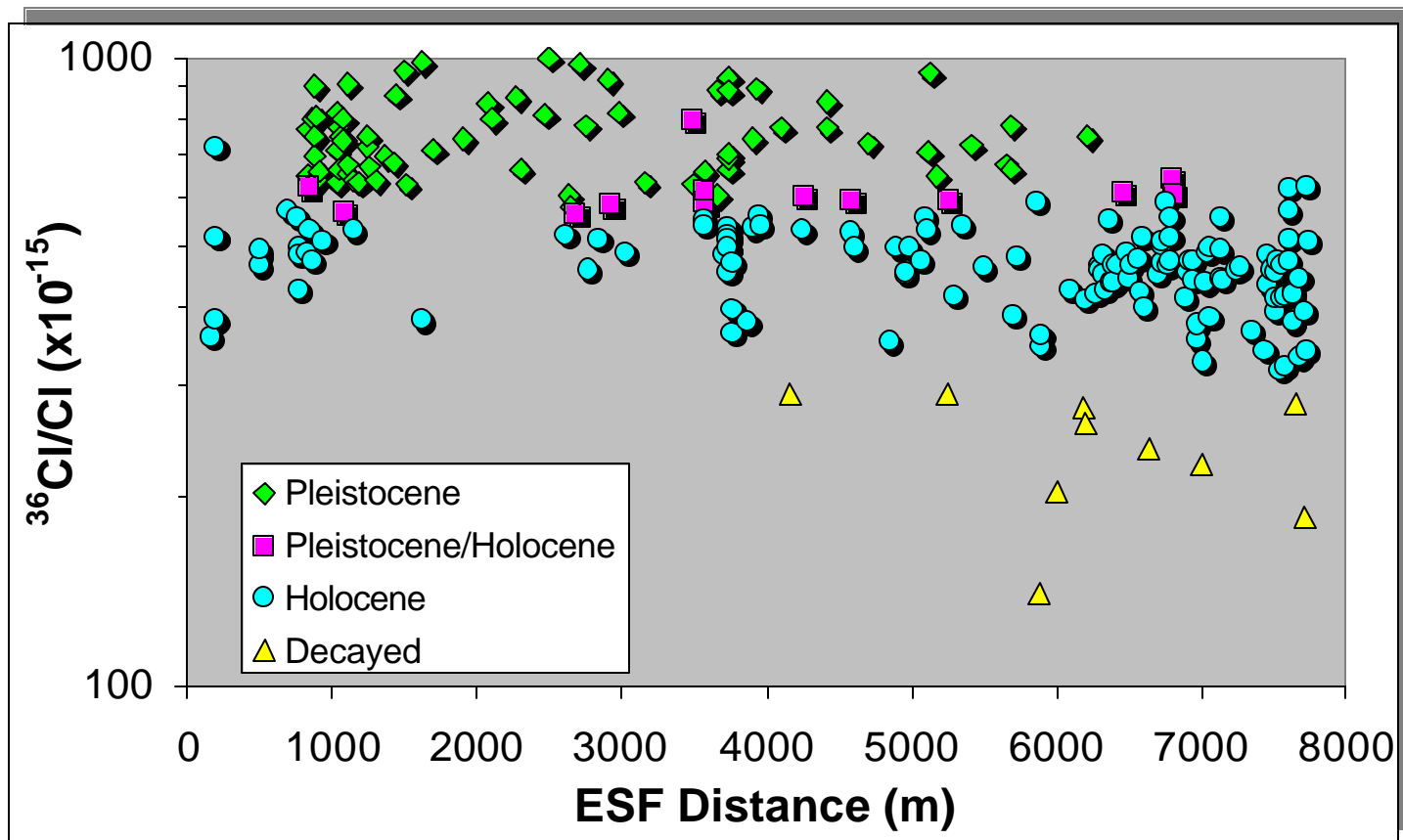


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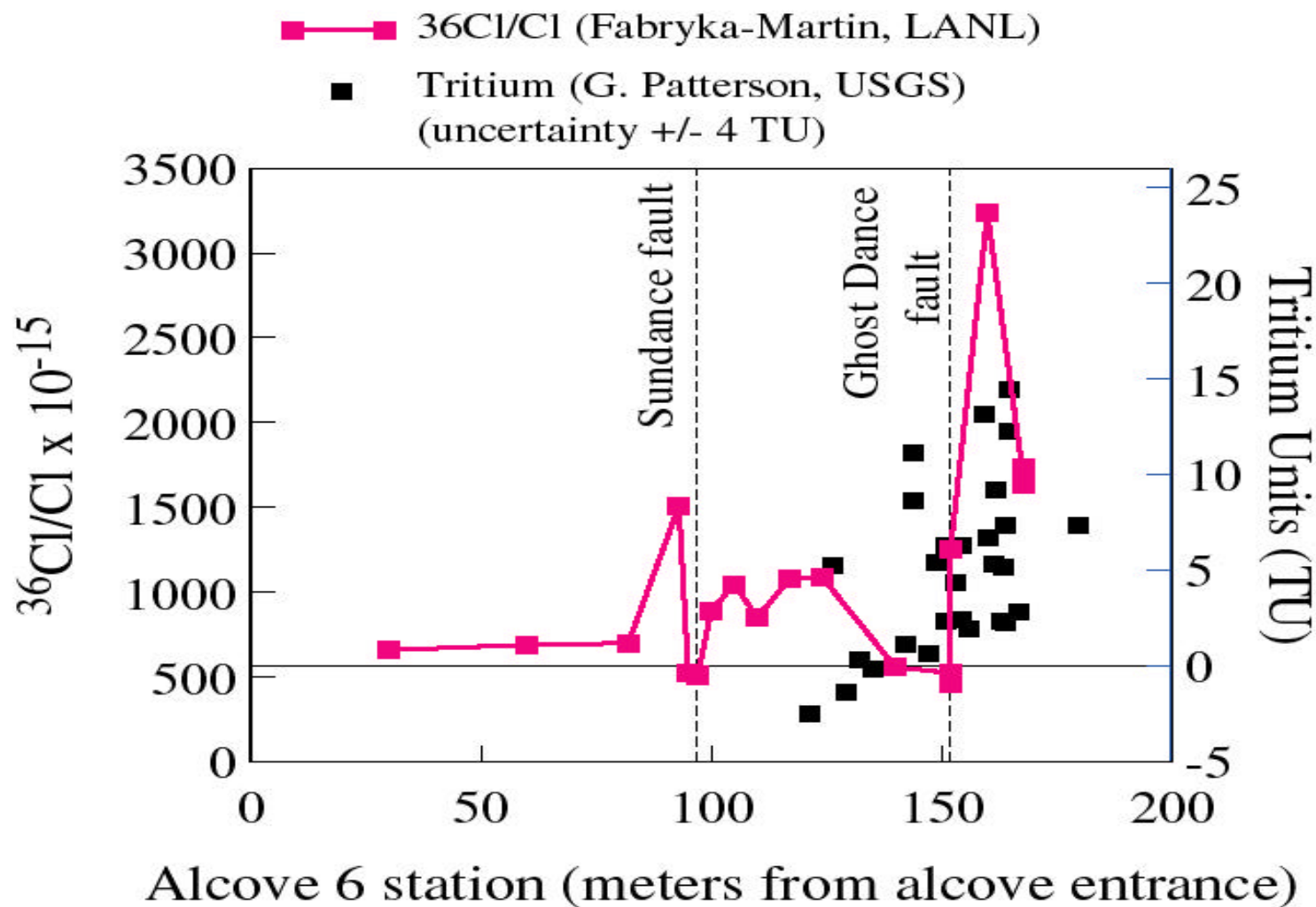
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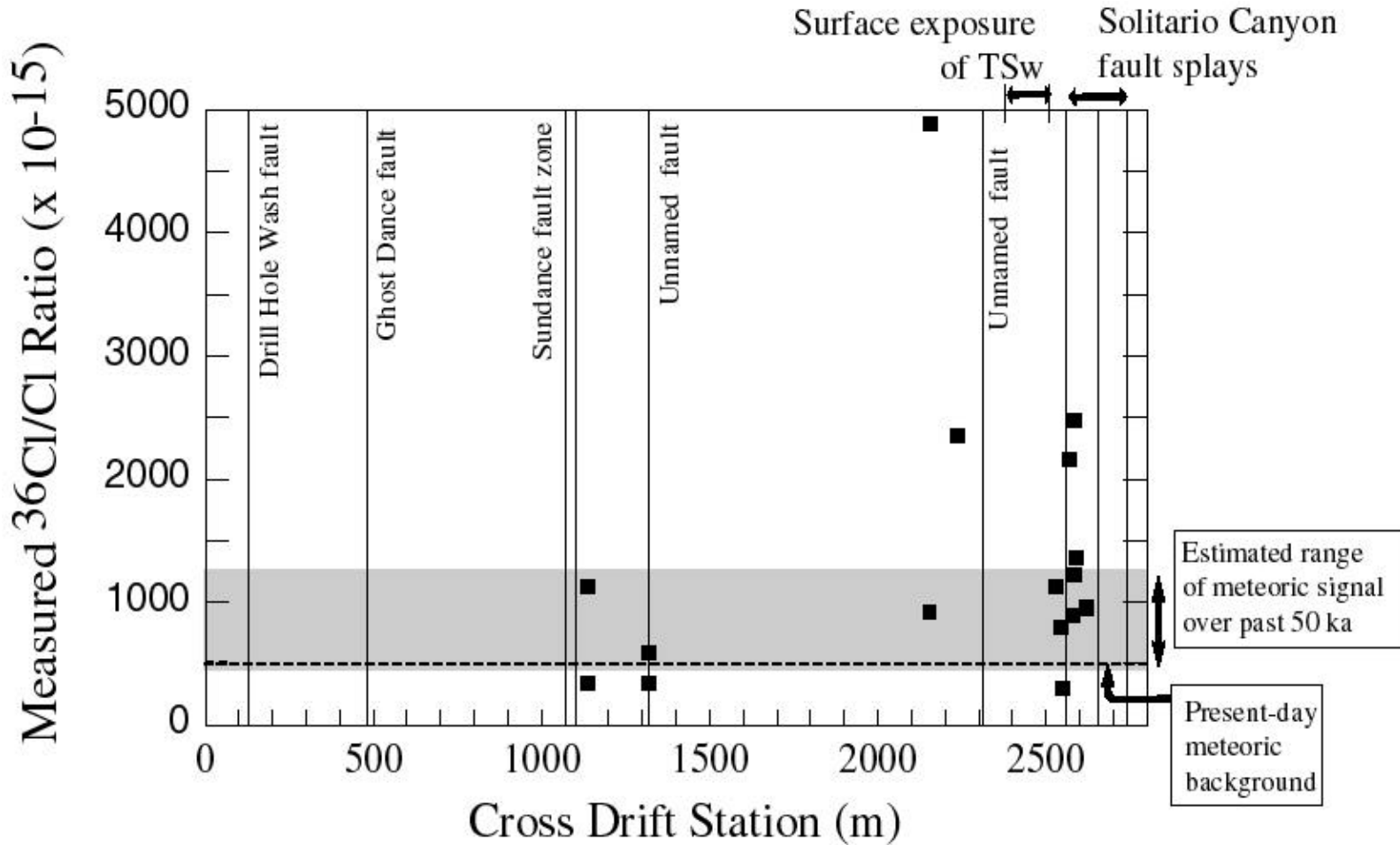


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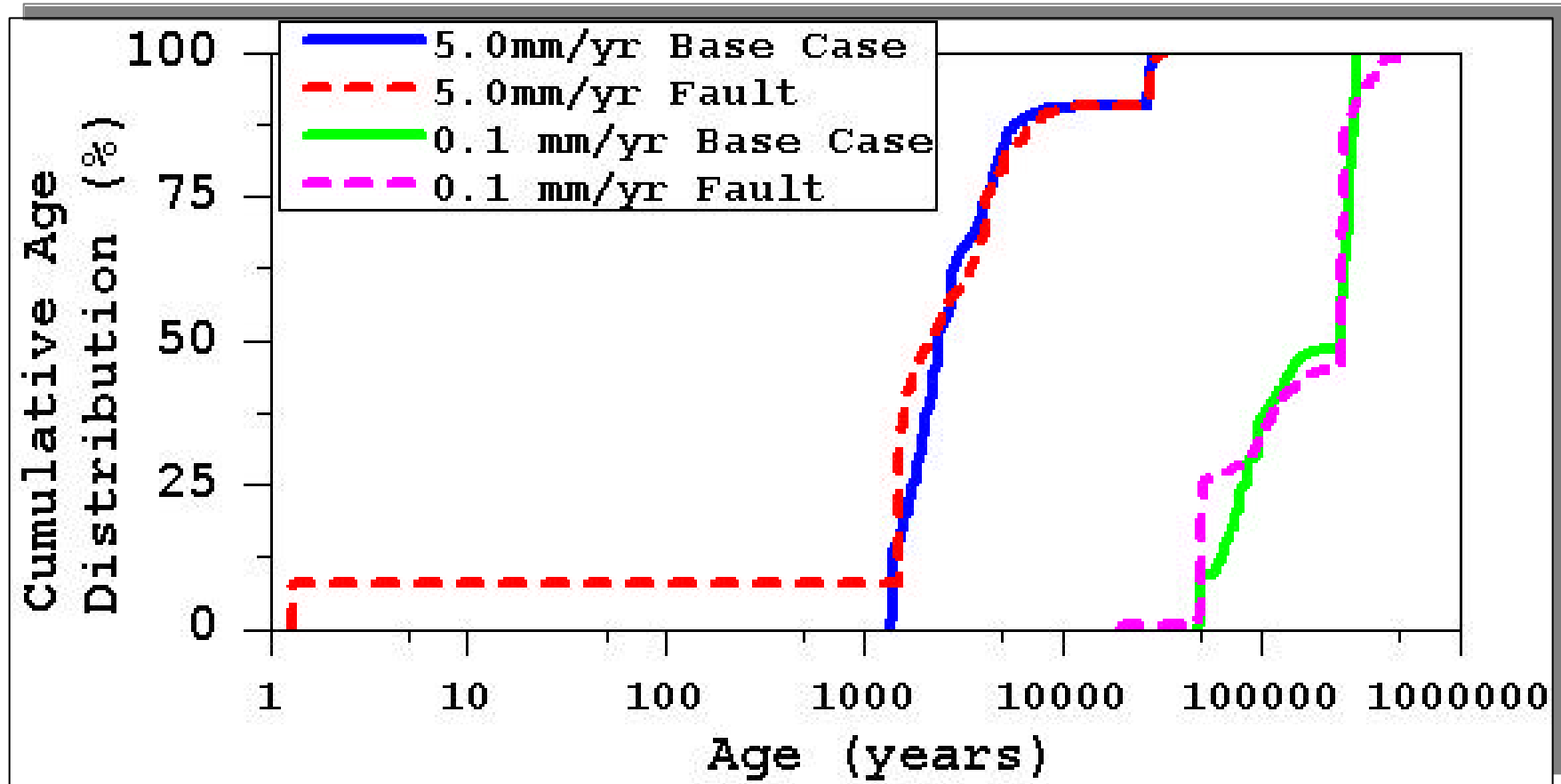
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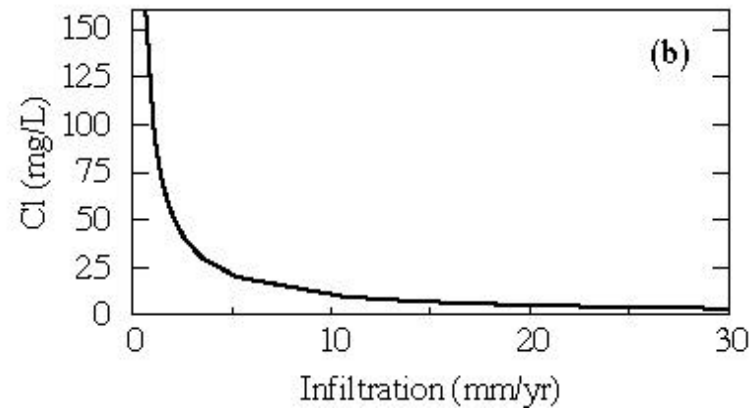
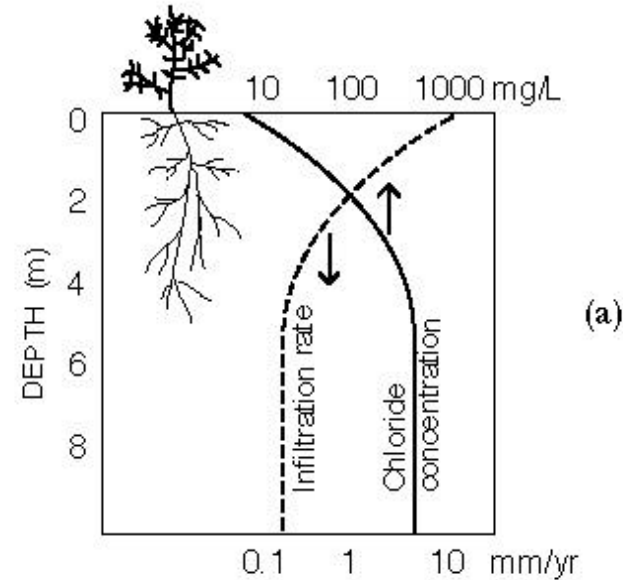
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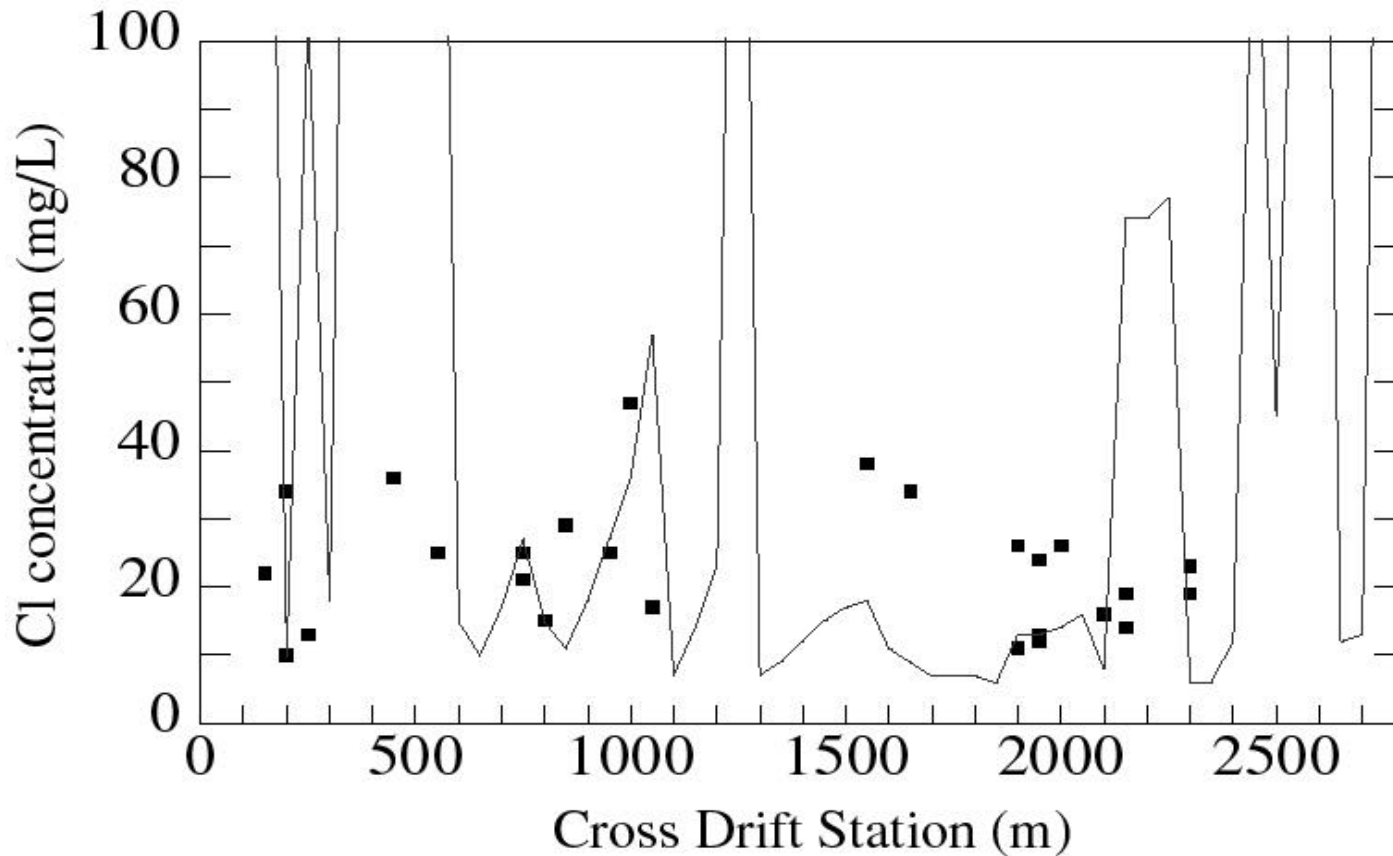
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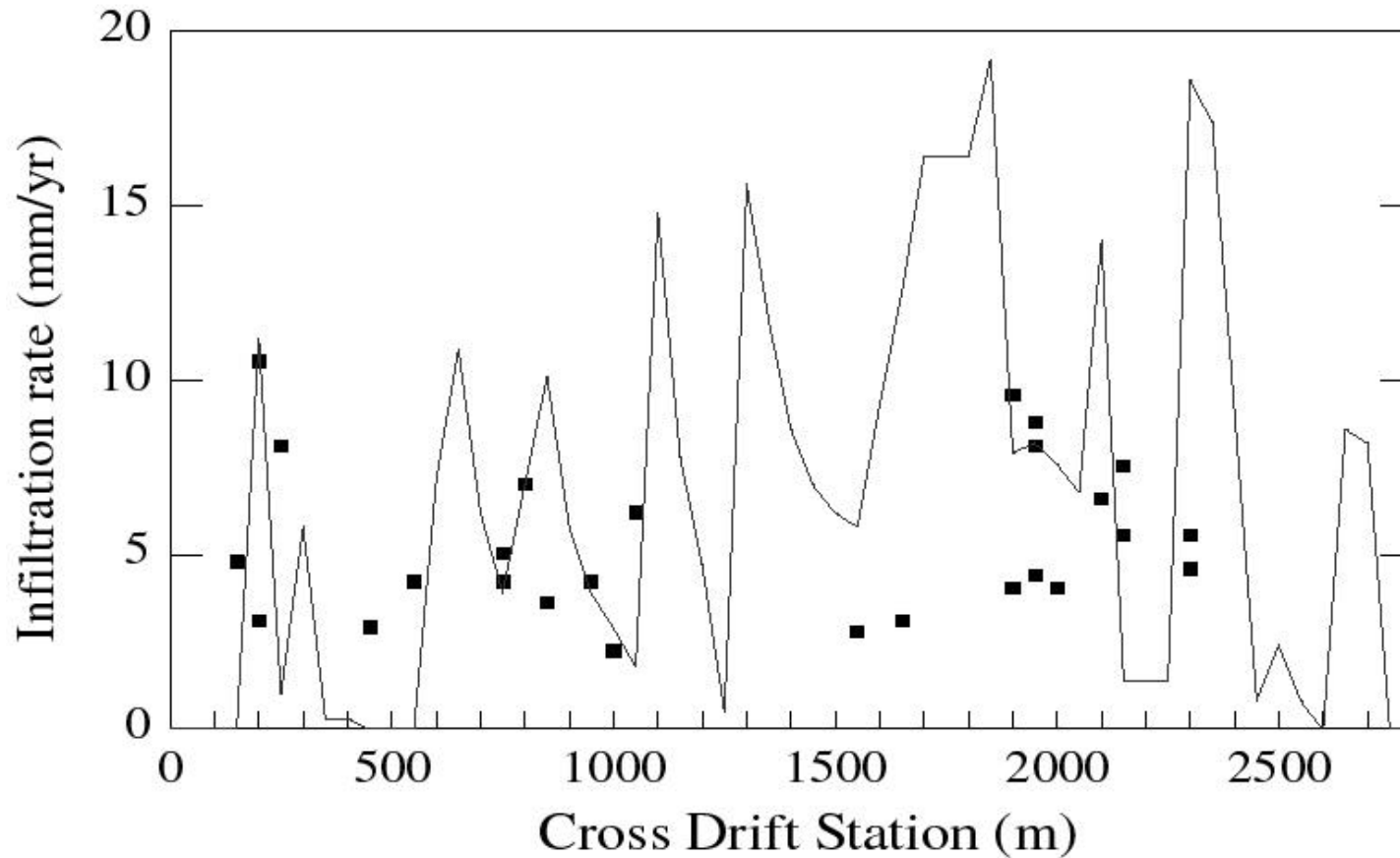
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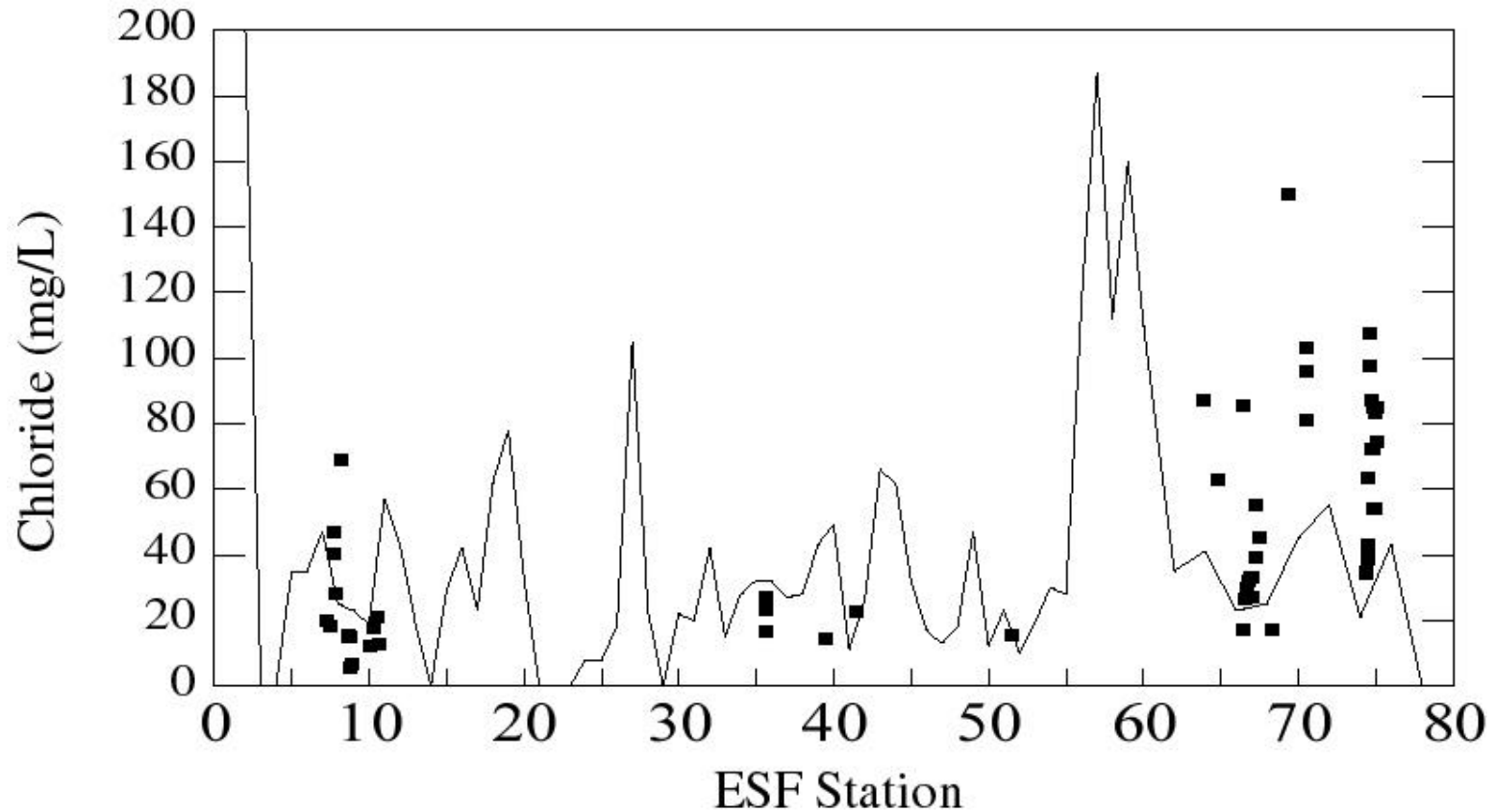
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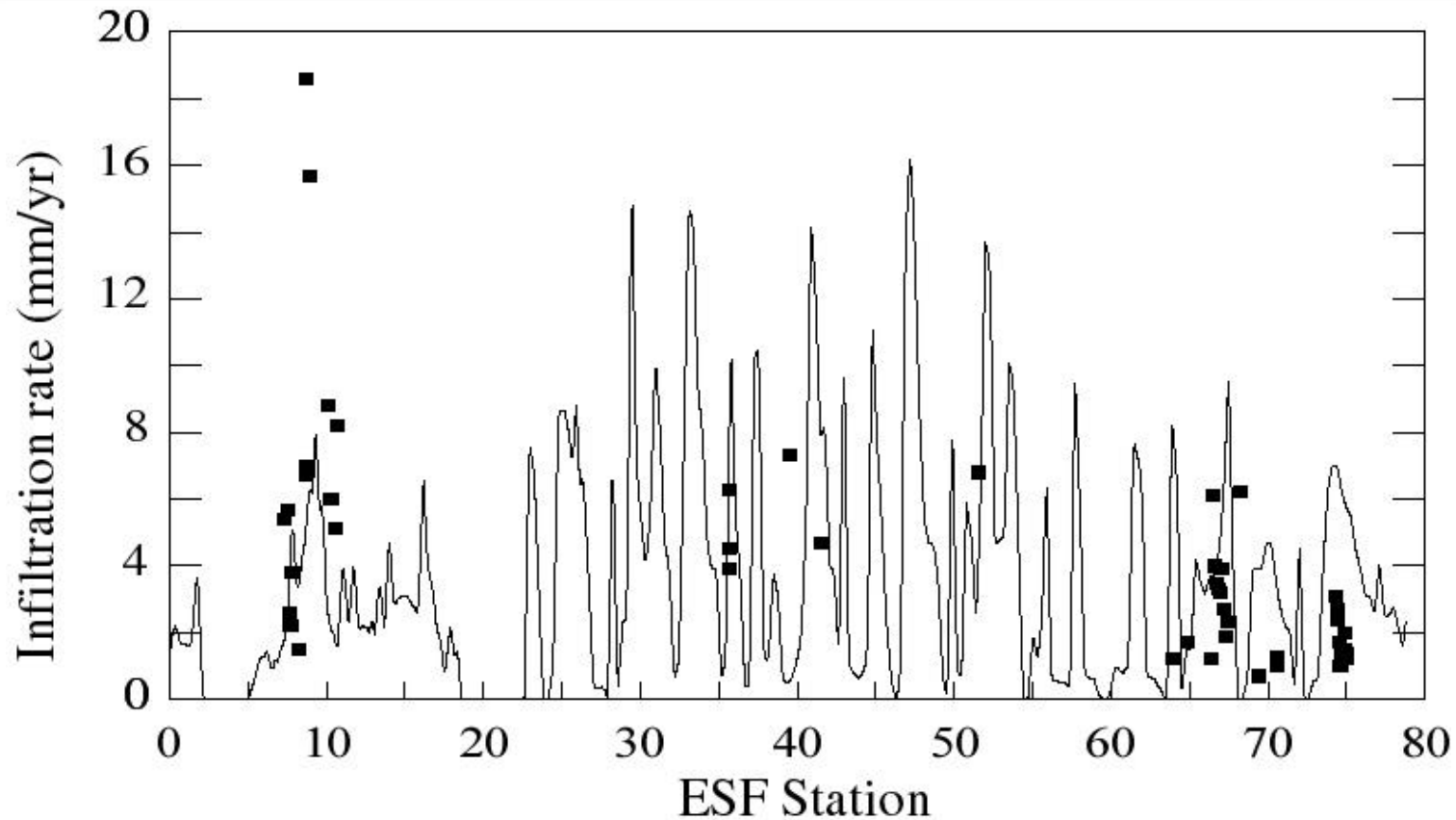
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# Summary and Conclusions



- **A distinct, four-component mixture model matches the observations well**

**Bomb-pulse (mean:1721)**

**Pleistocene (mean:740)**

**Holocene (mean:480)**

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- **The bomb-pulse observations are correlated with faults in the northern ESF. This conclusion is based on the distribution of elevated  $^{36}\text{Cl}/\text{Cl}$  ratios in the ESF and Cross Drift, and is also supported by elevated pH levels in several deep boreholes and in 2 ESF alcoves, as well as limited Tc-99 measurements.**
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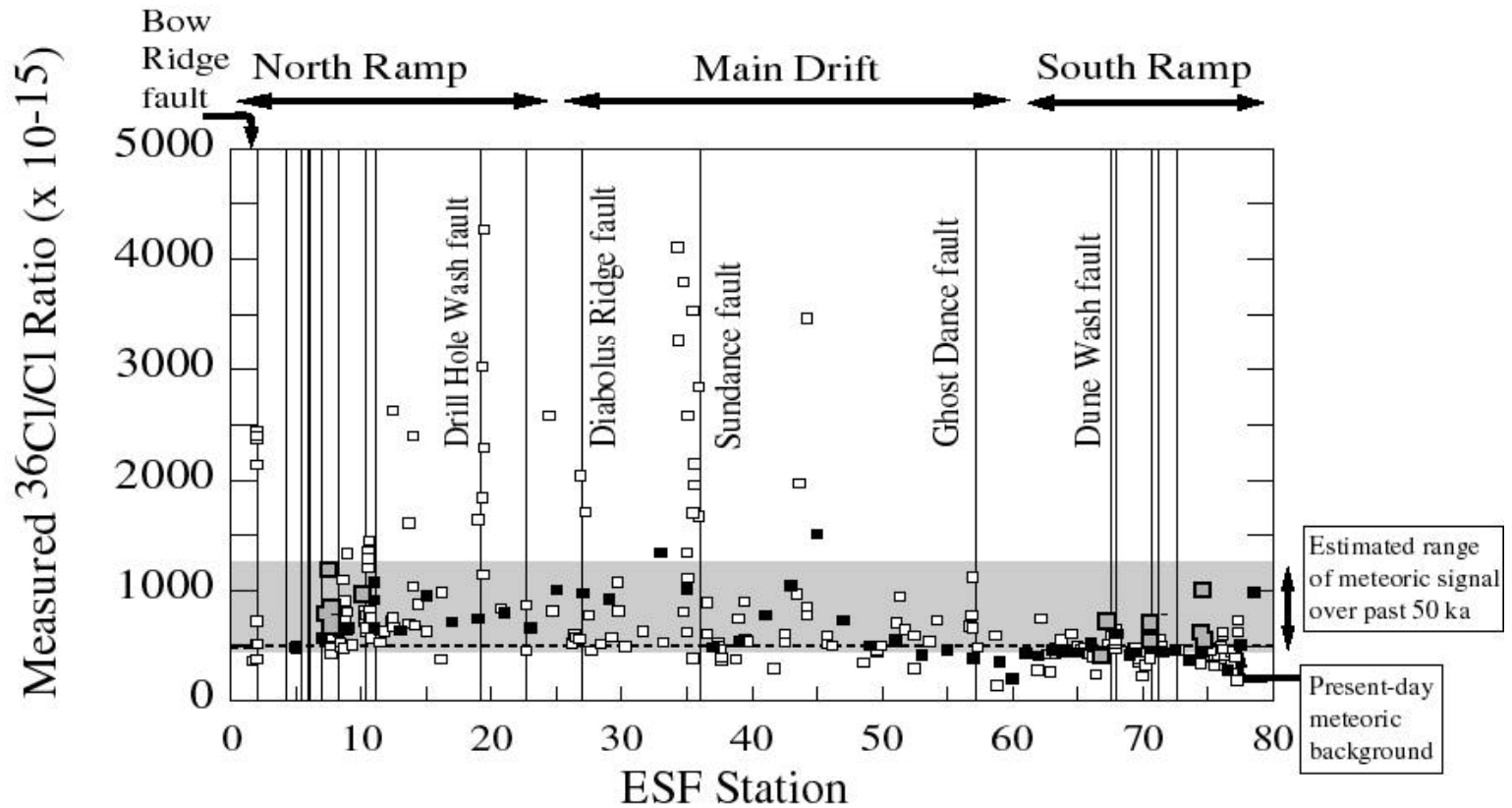
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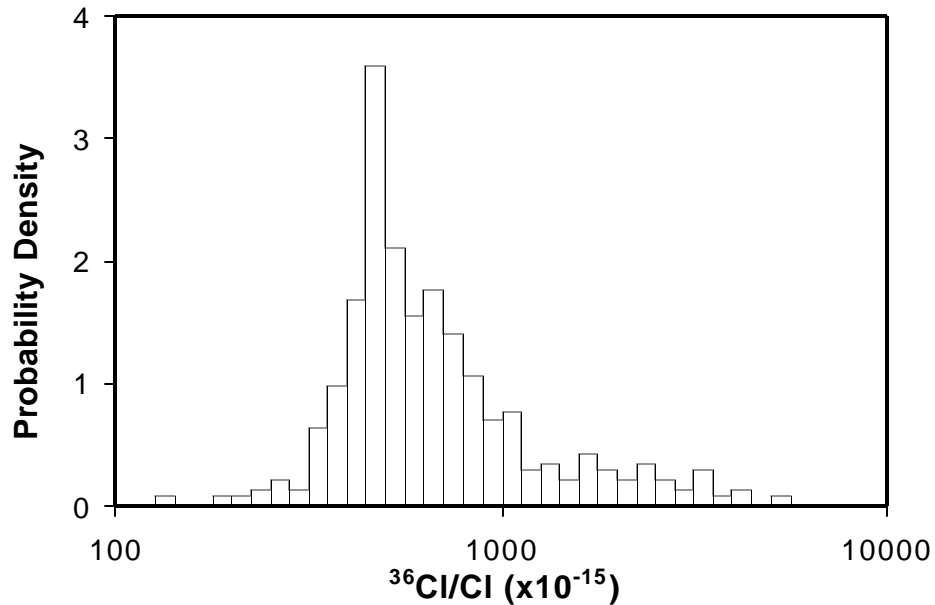


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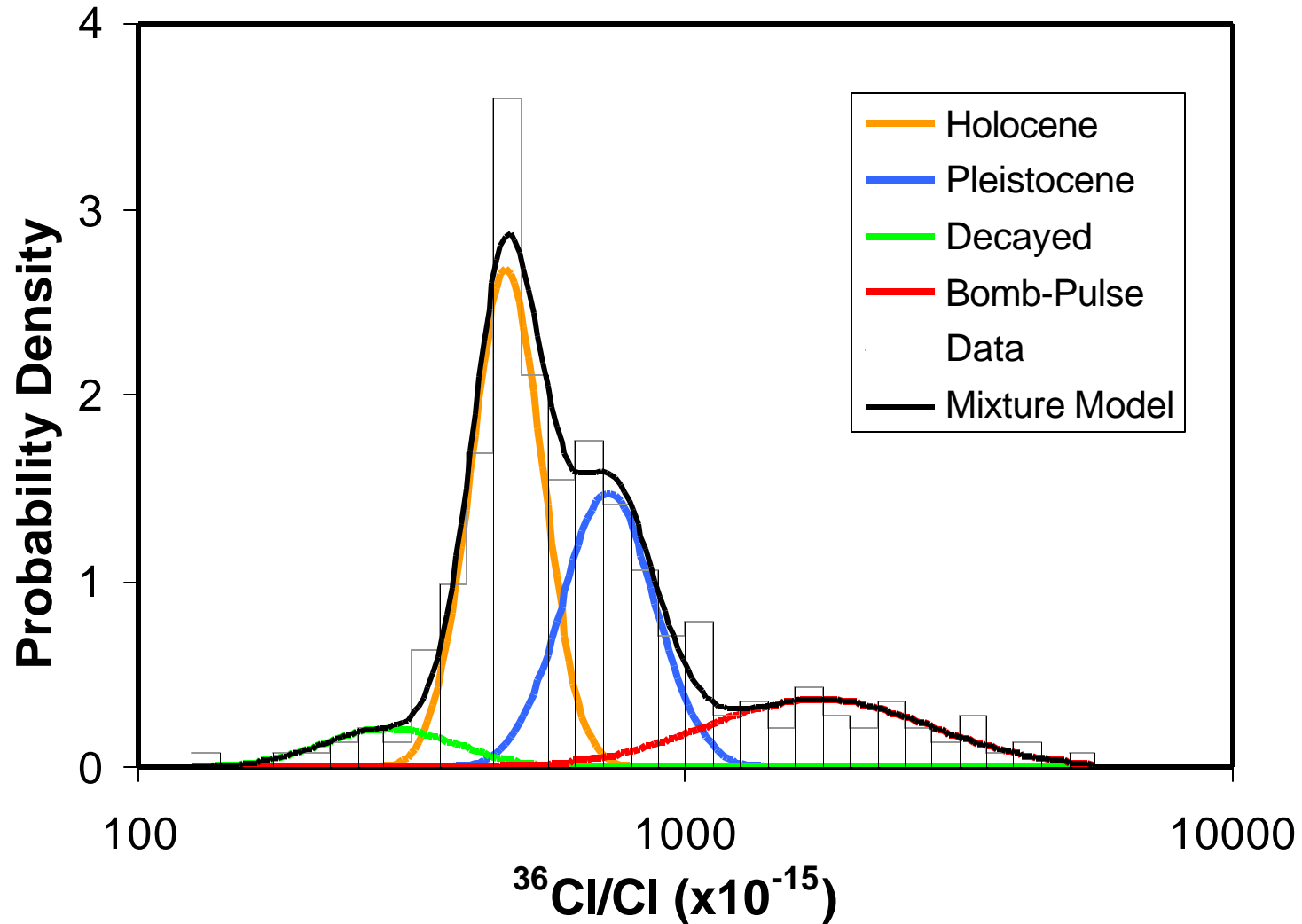
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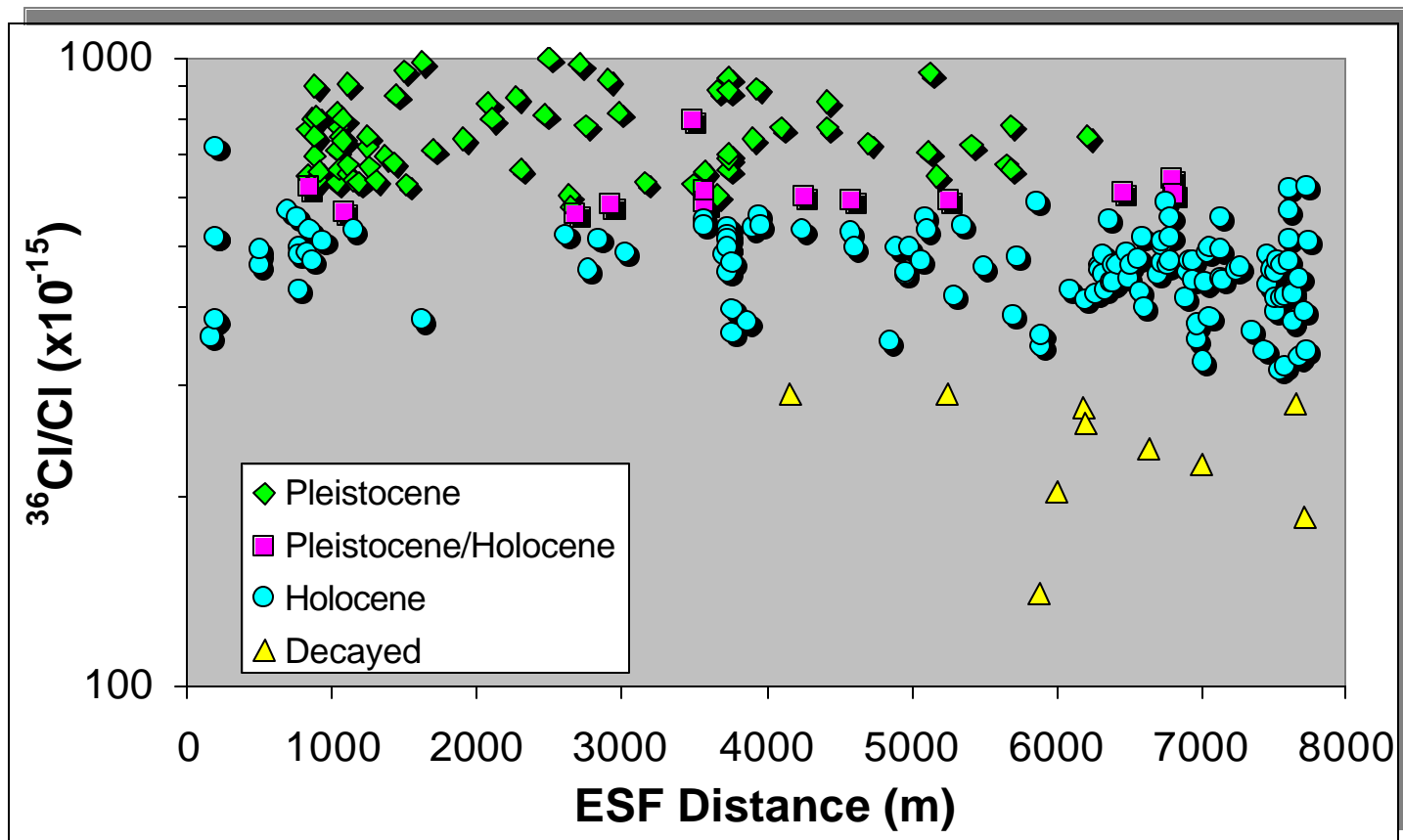


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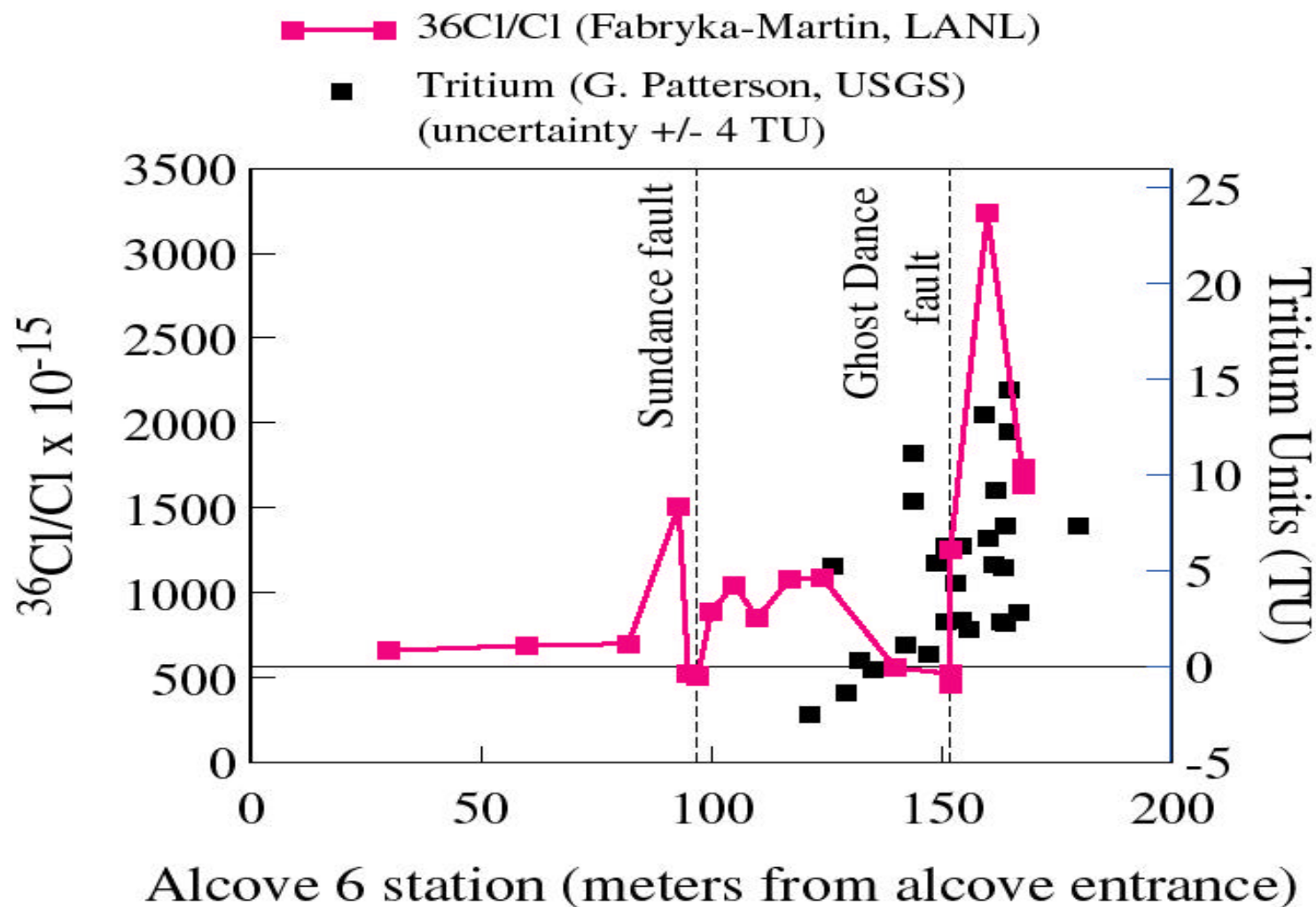
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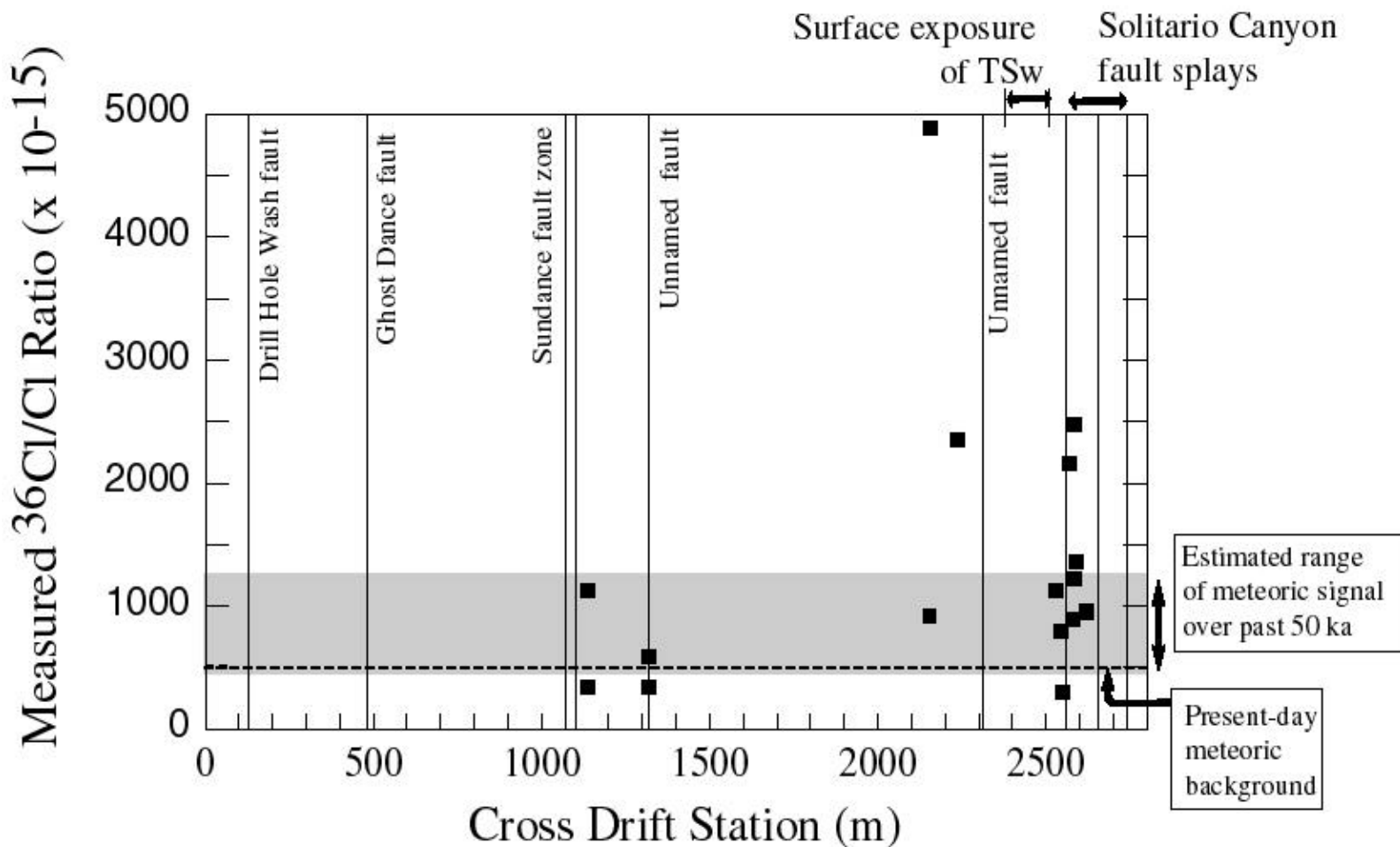
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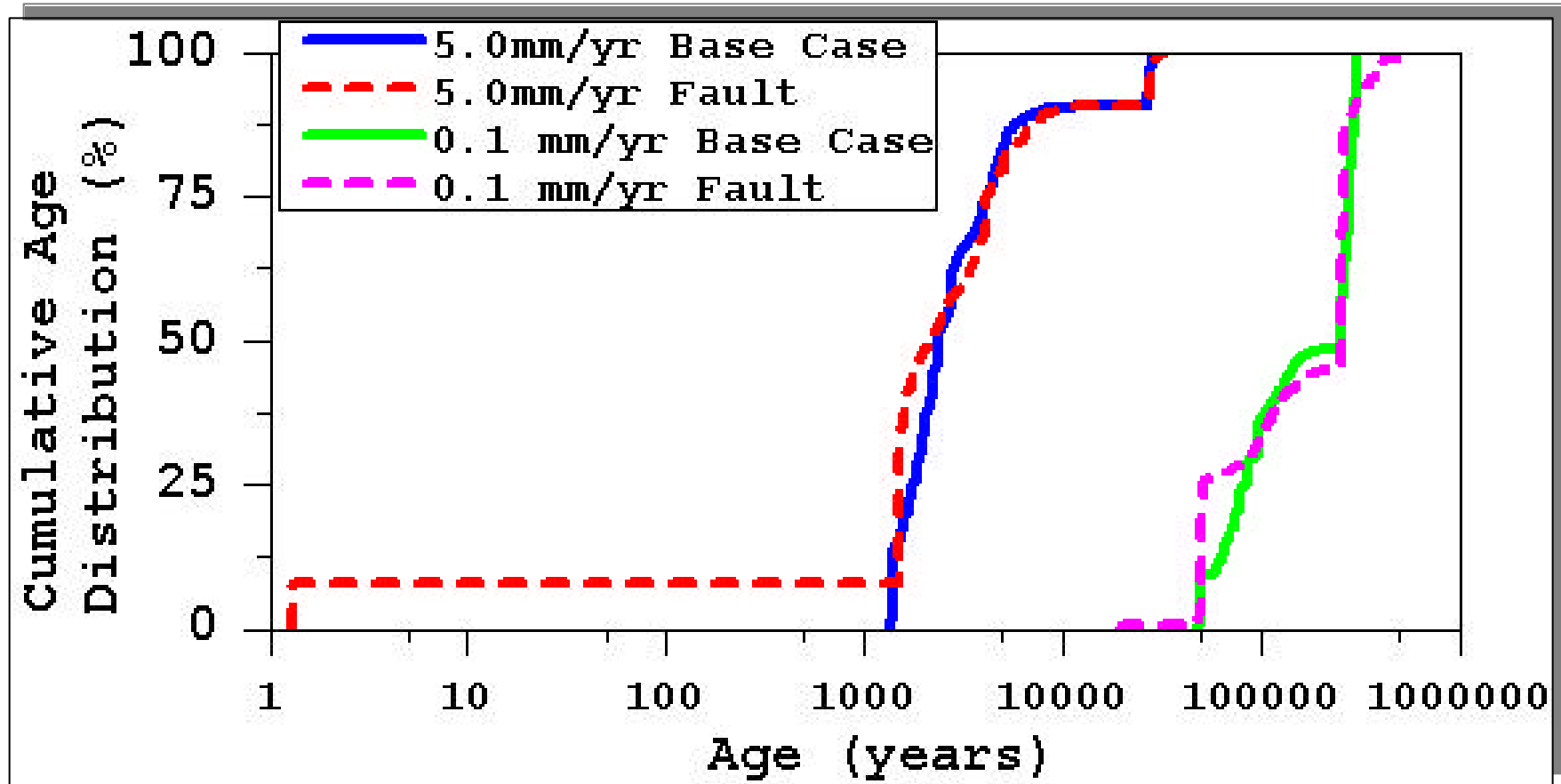
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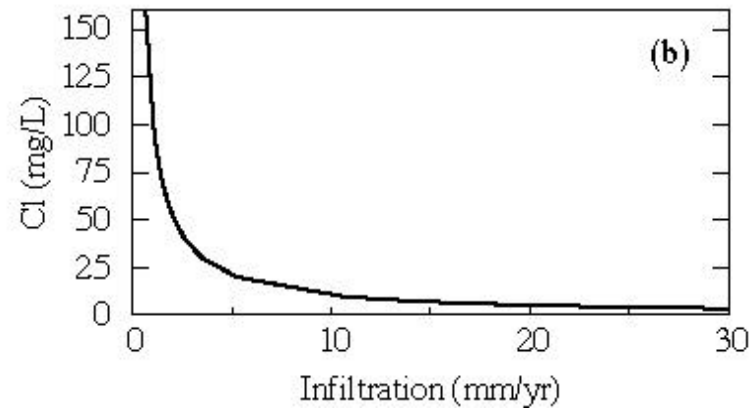
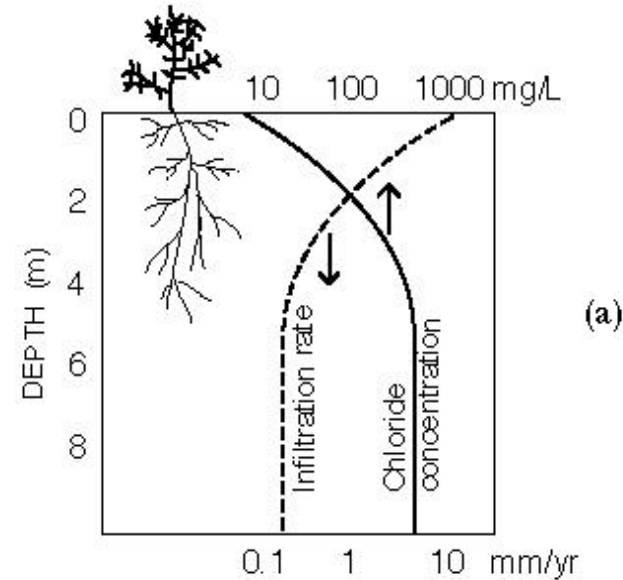
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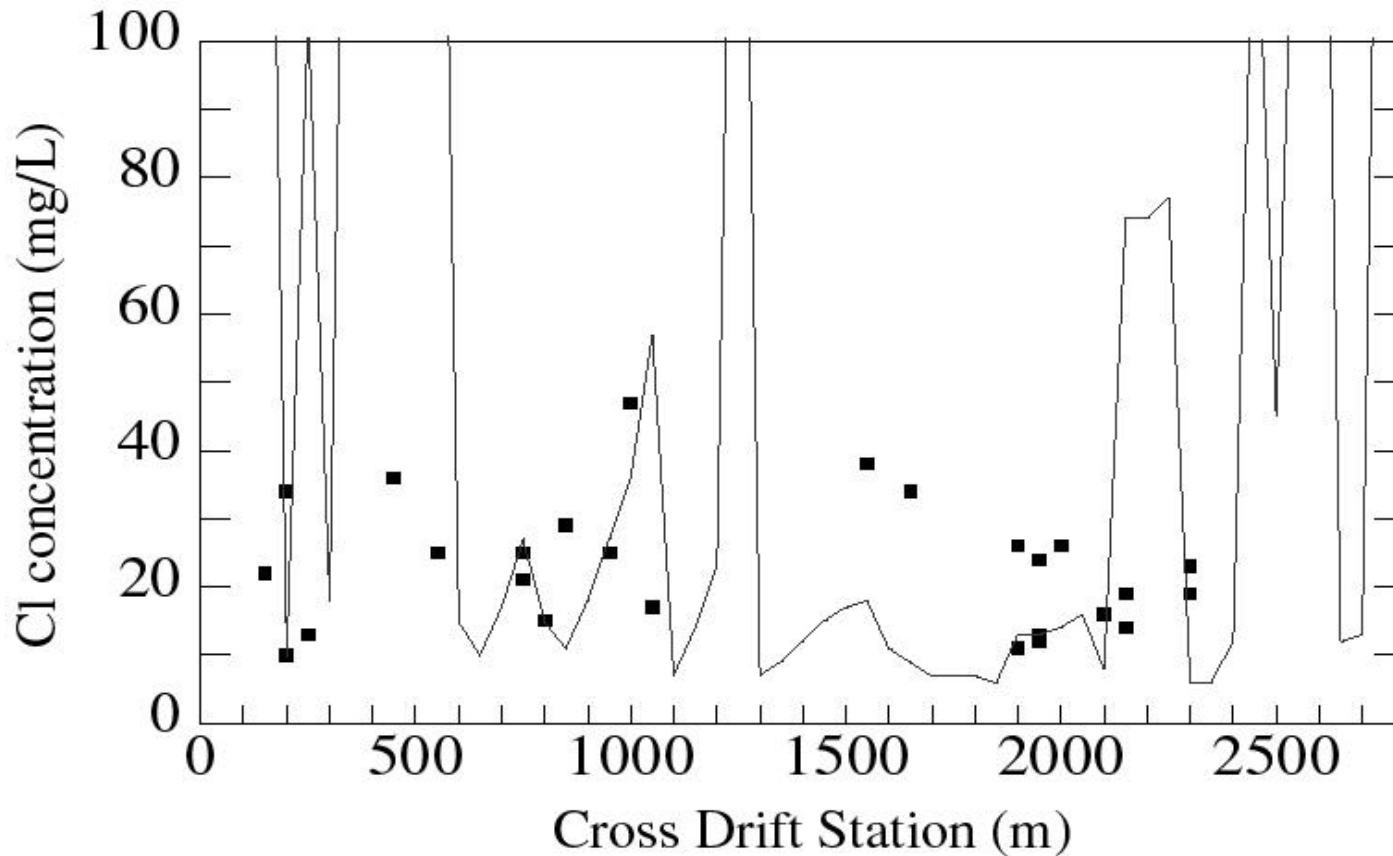


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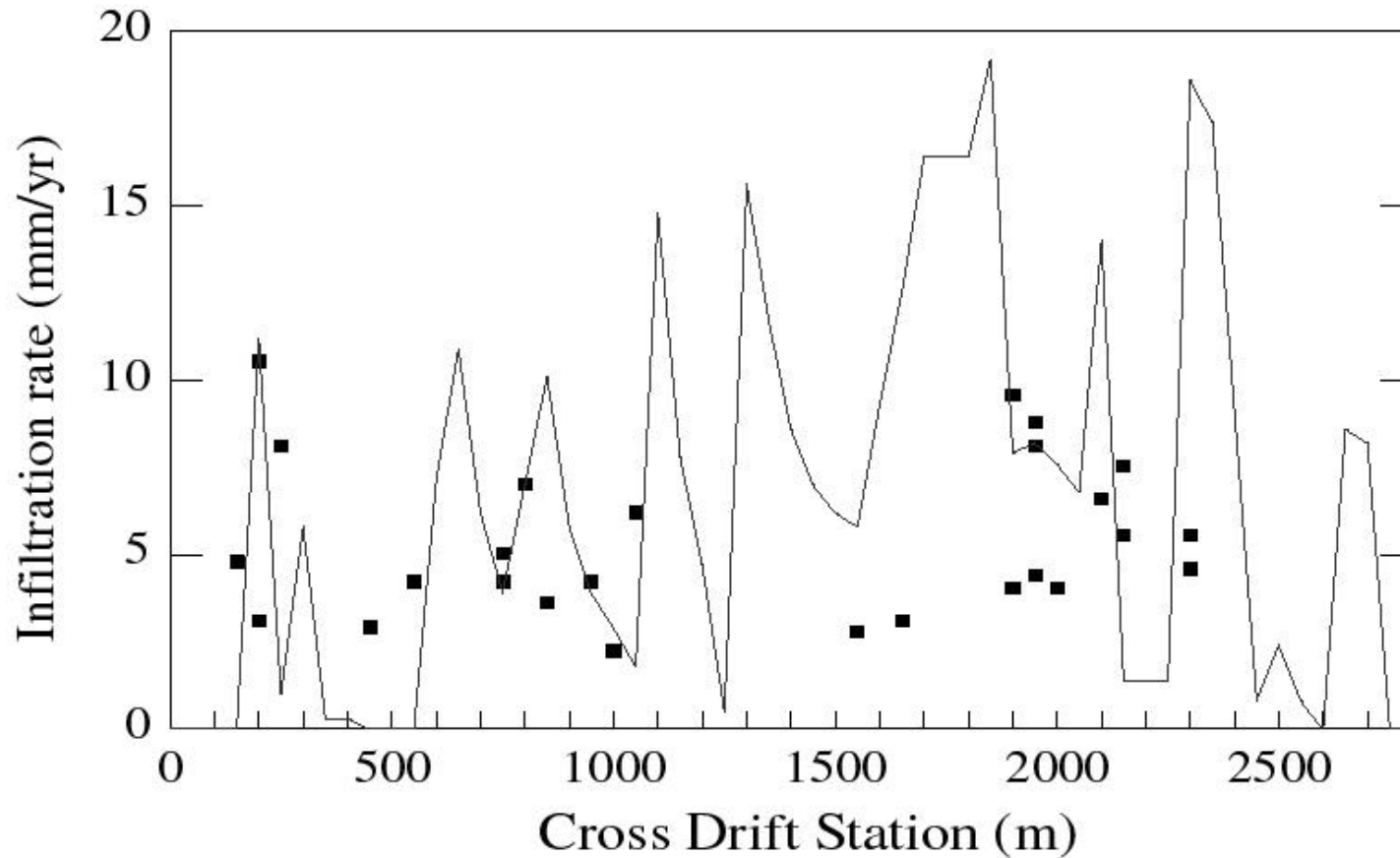
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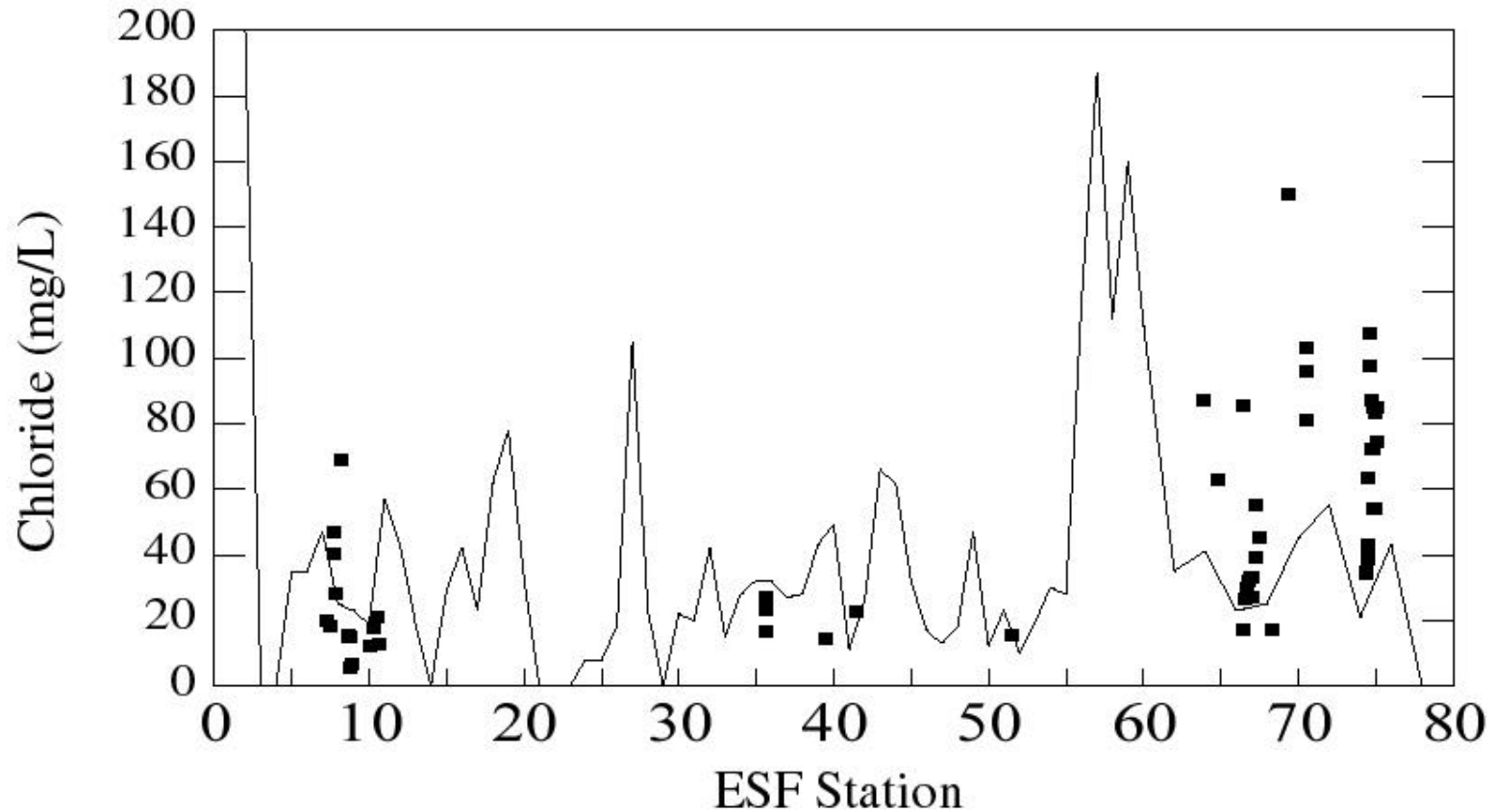
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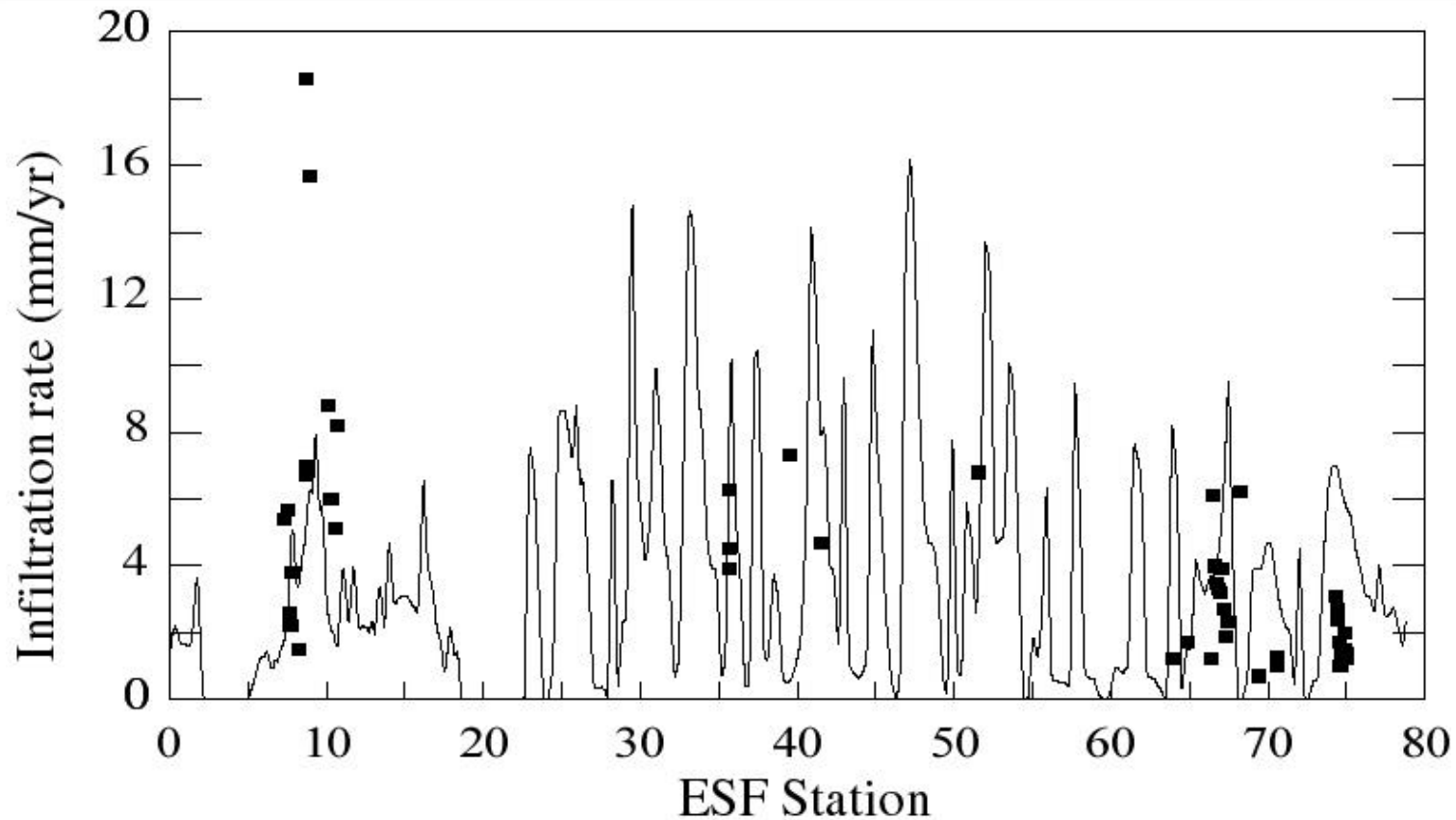
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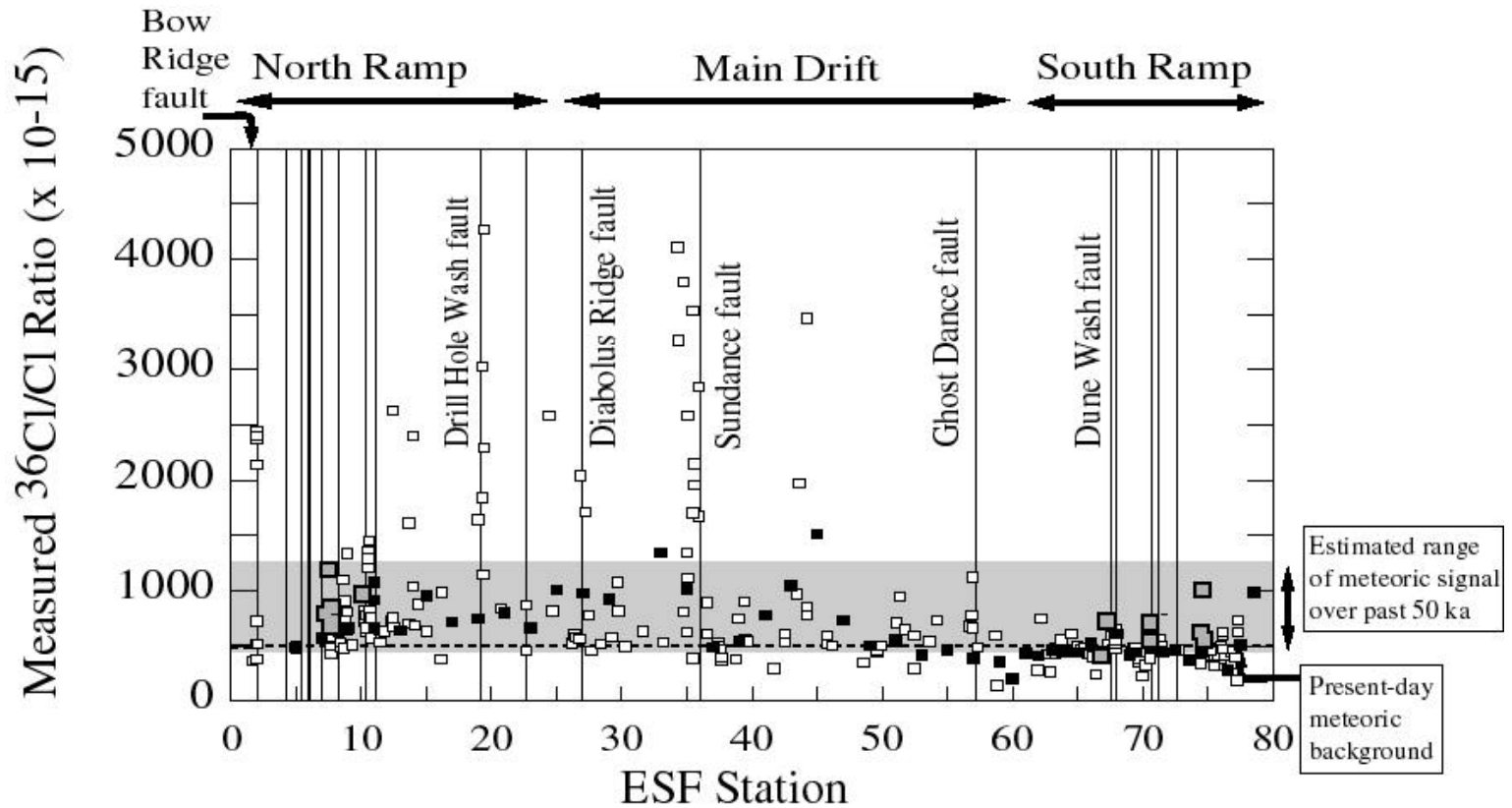
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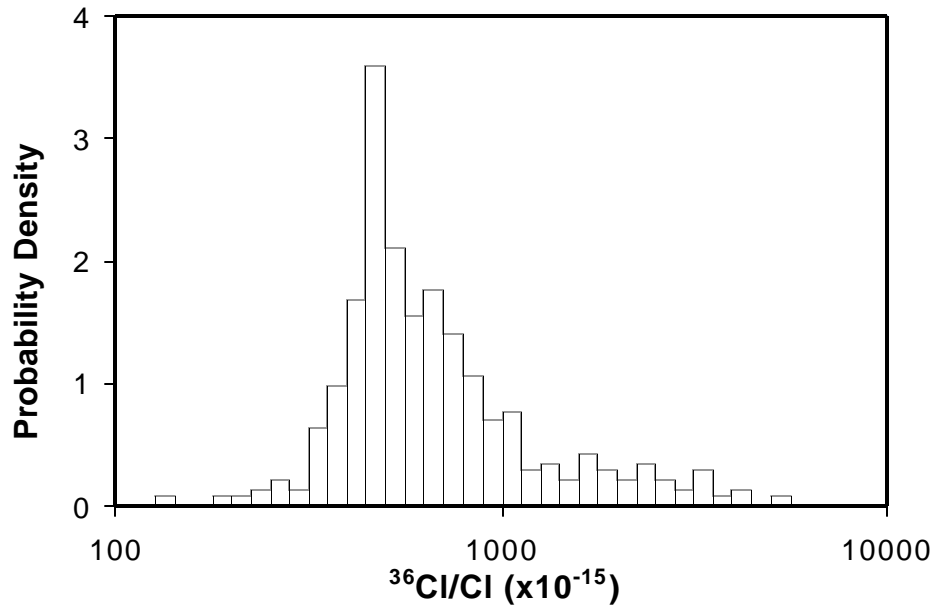
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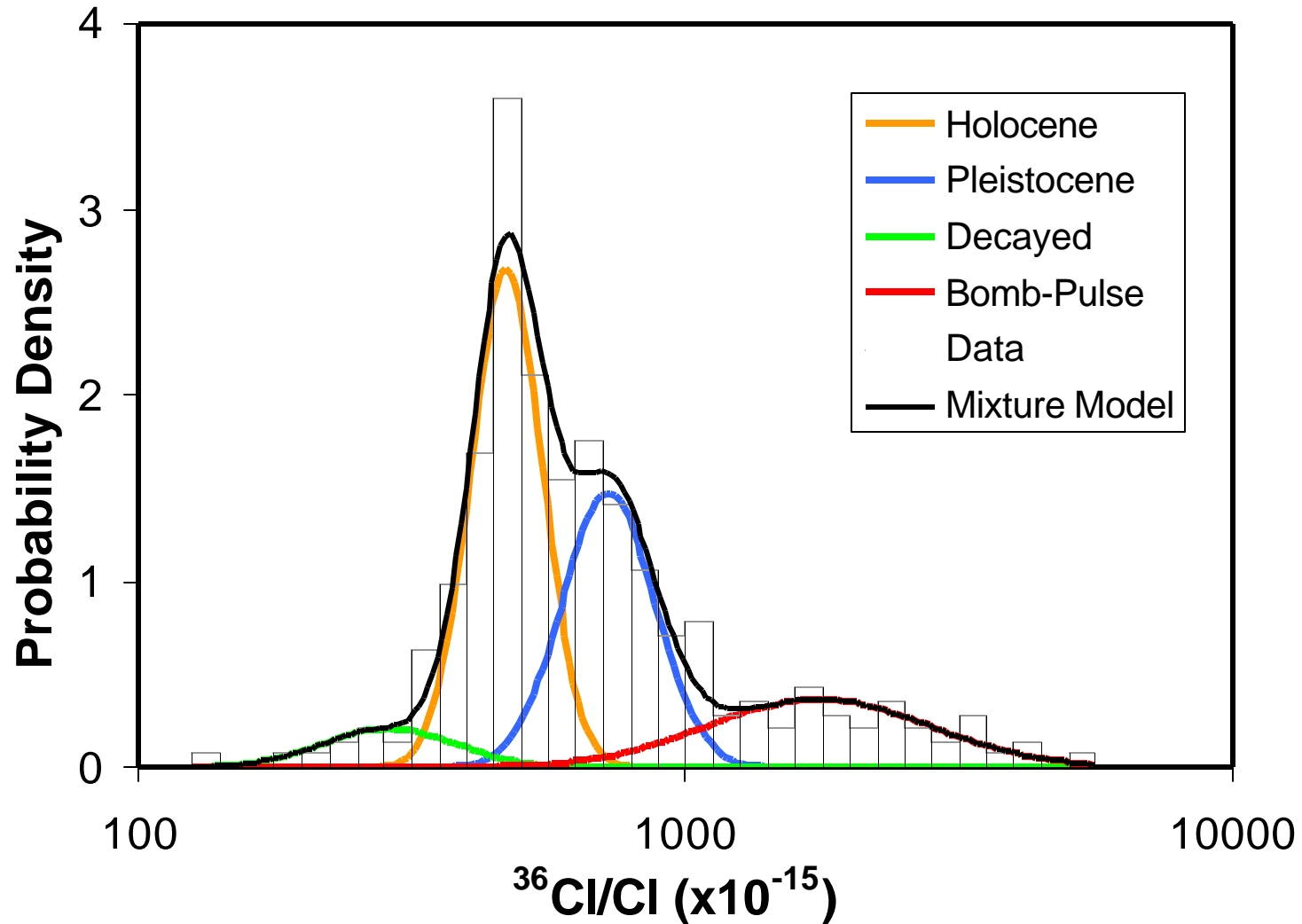
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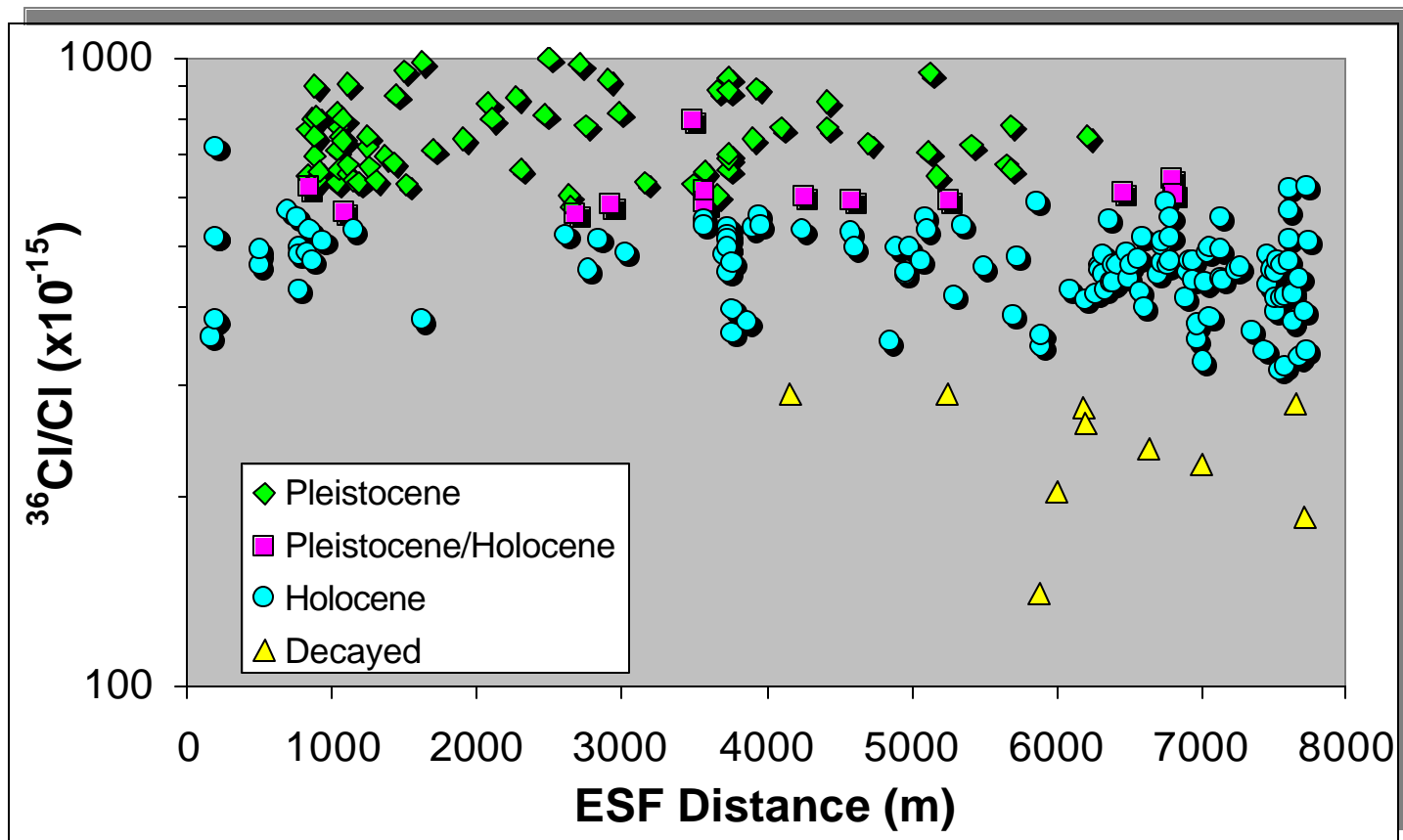
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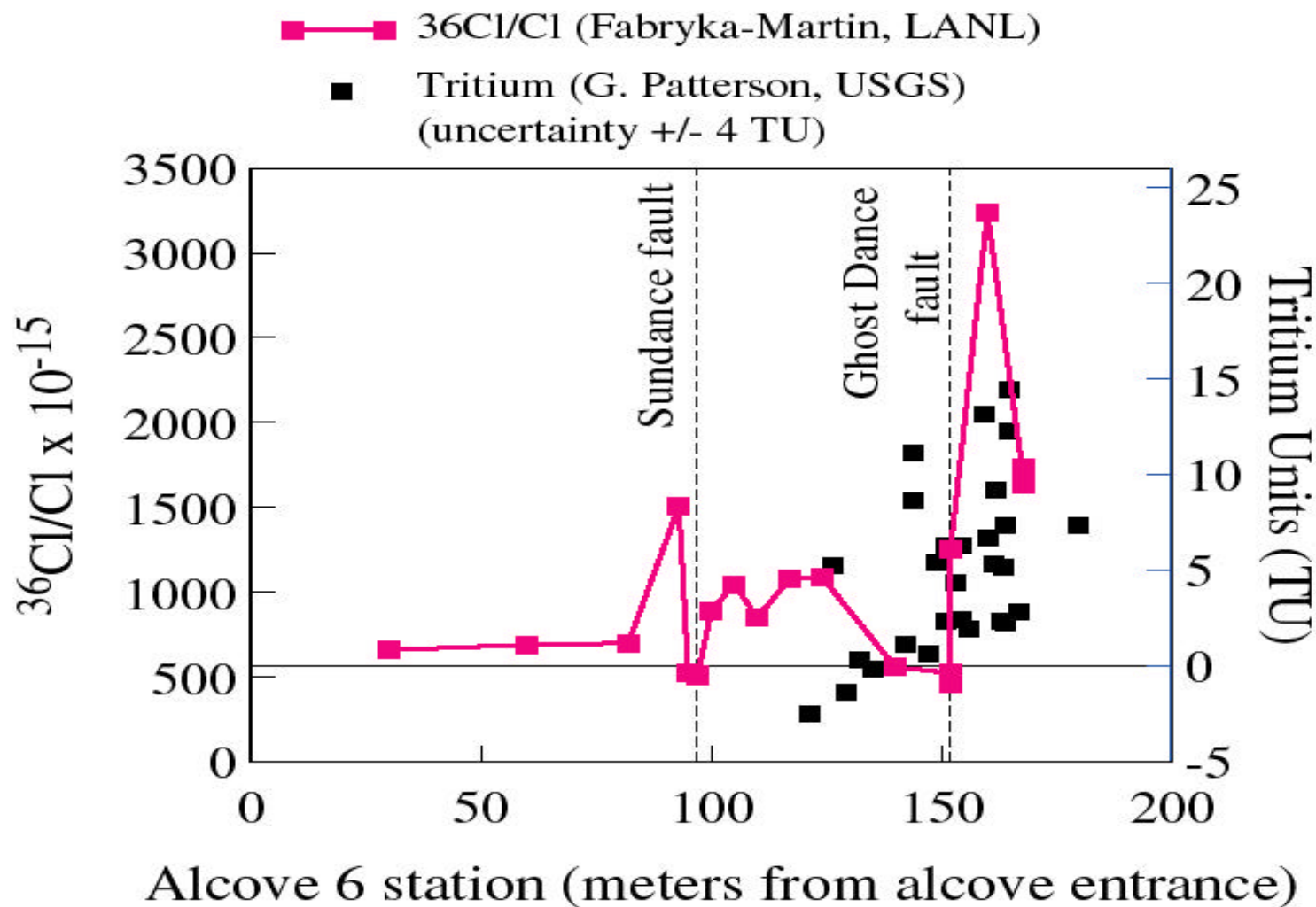
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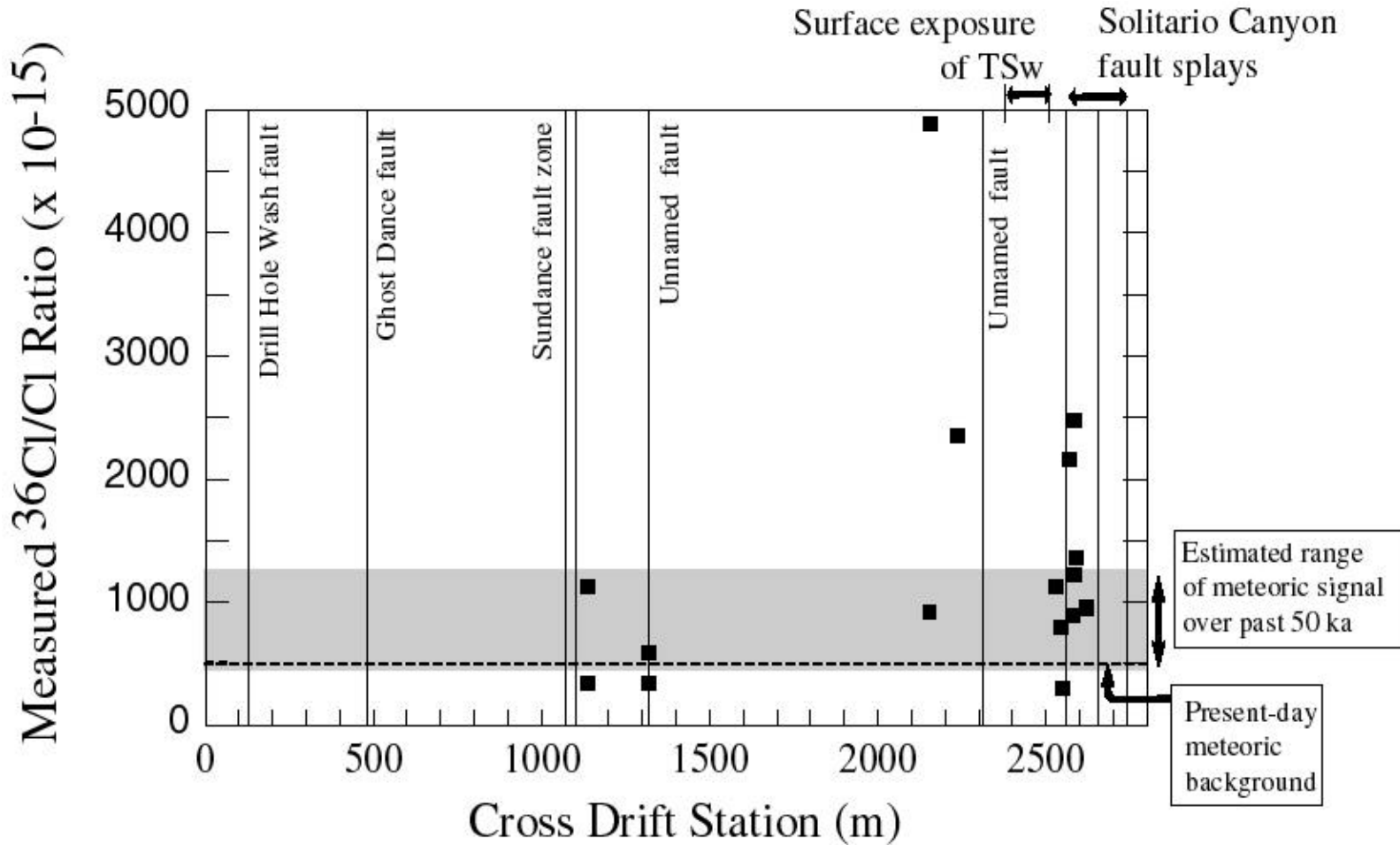
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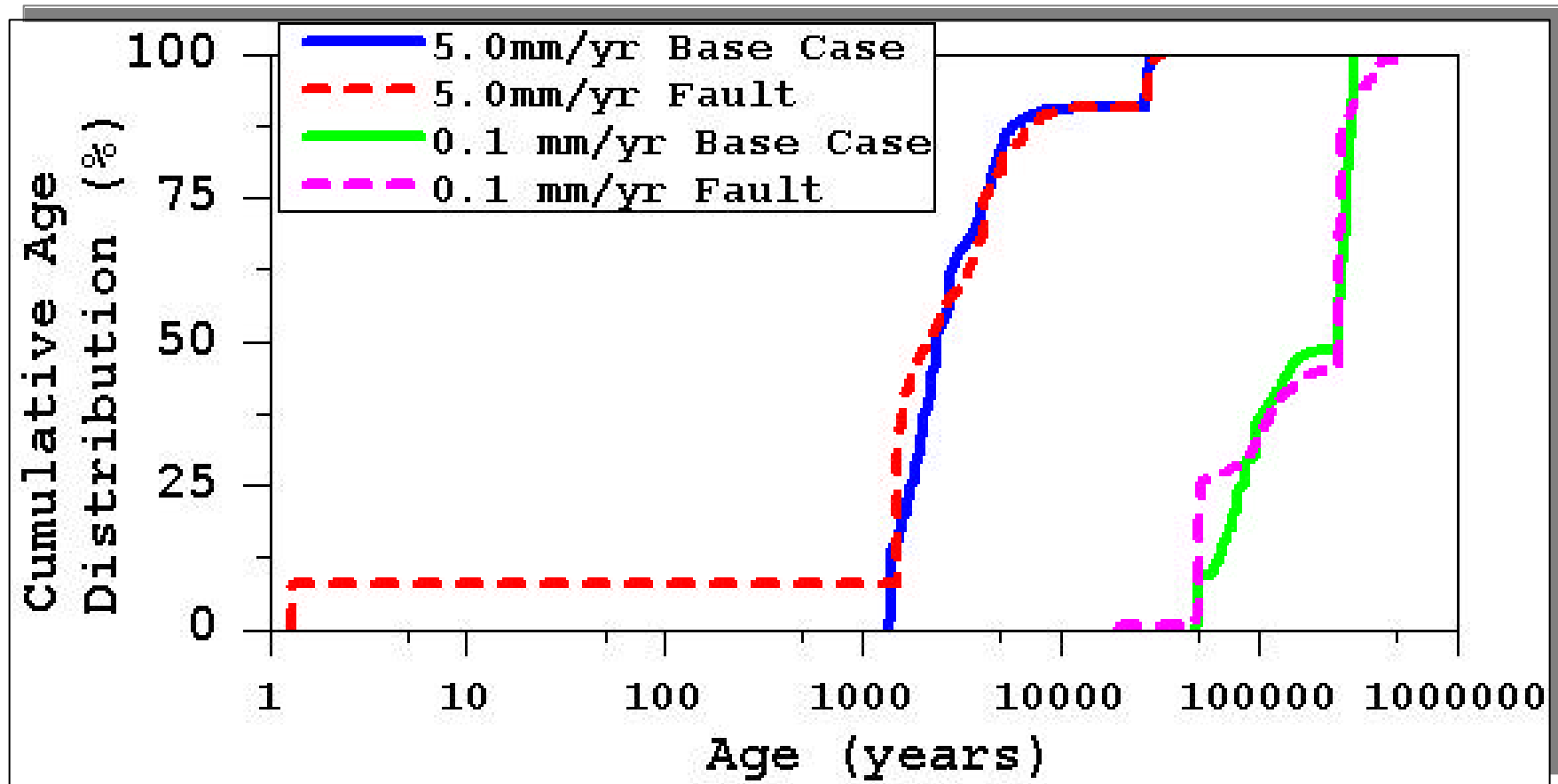
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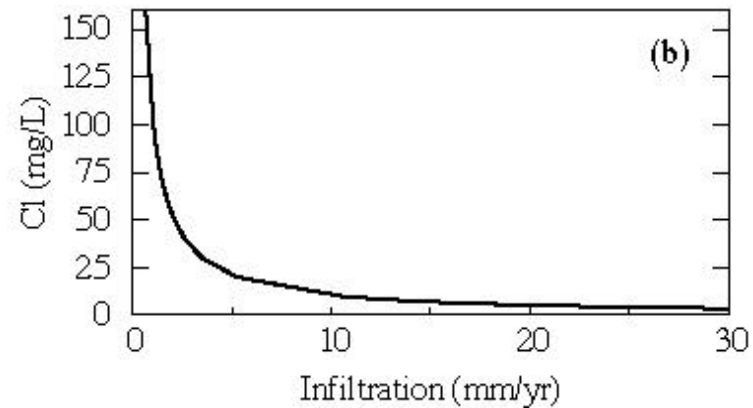
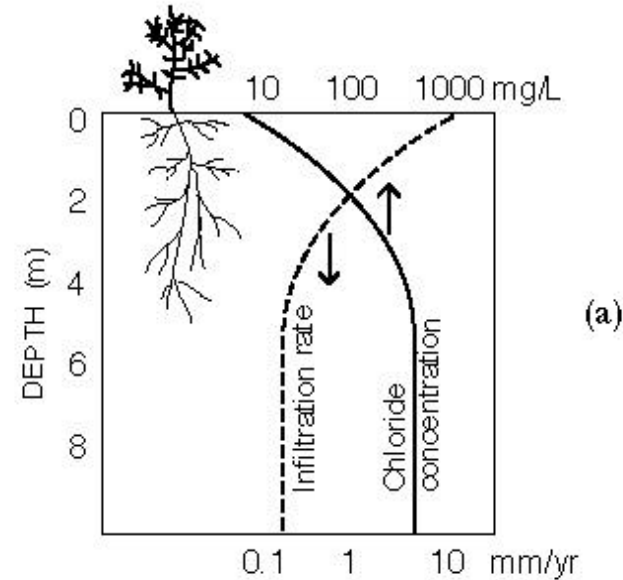
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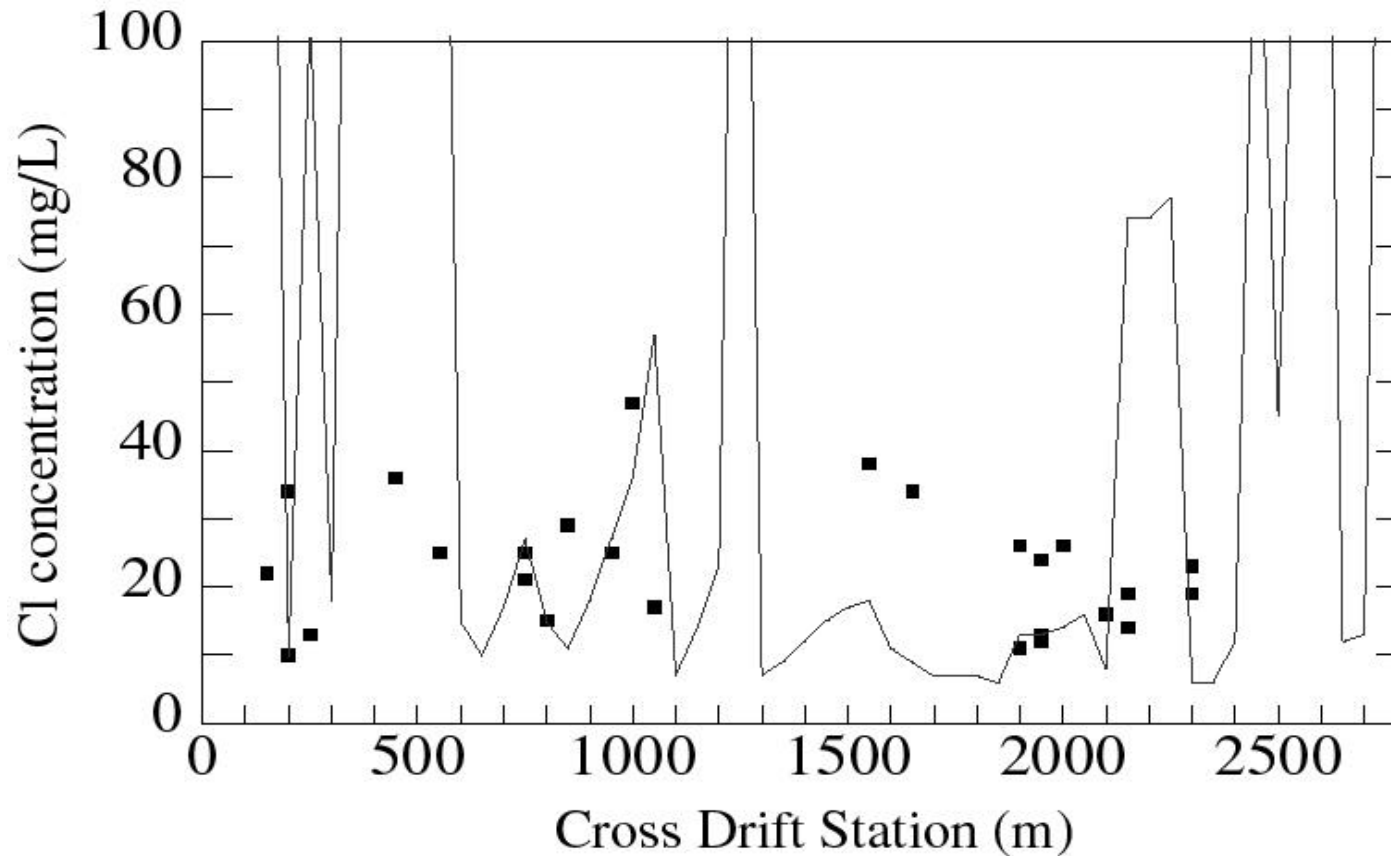
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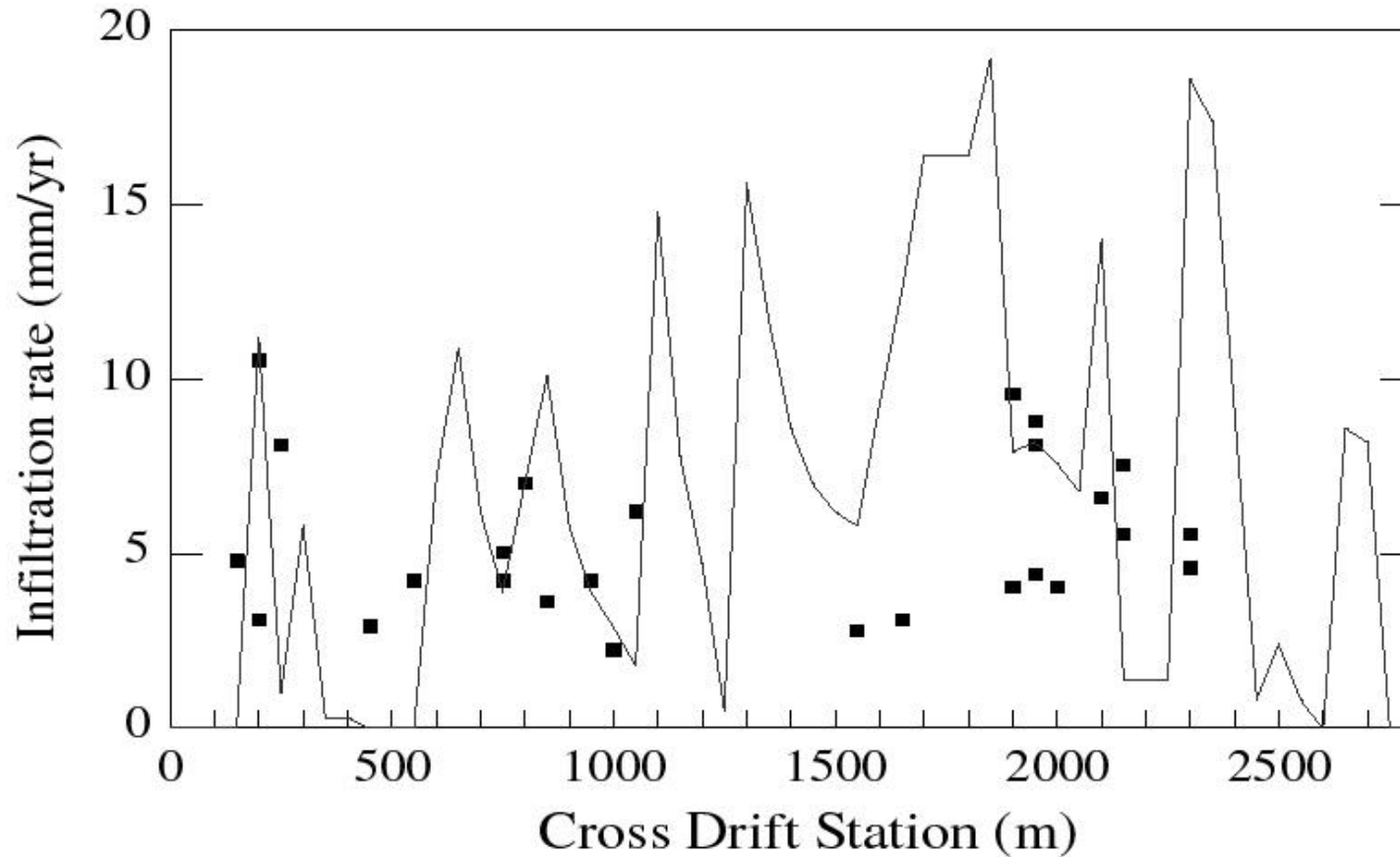
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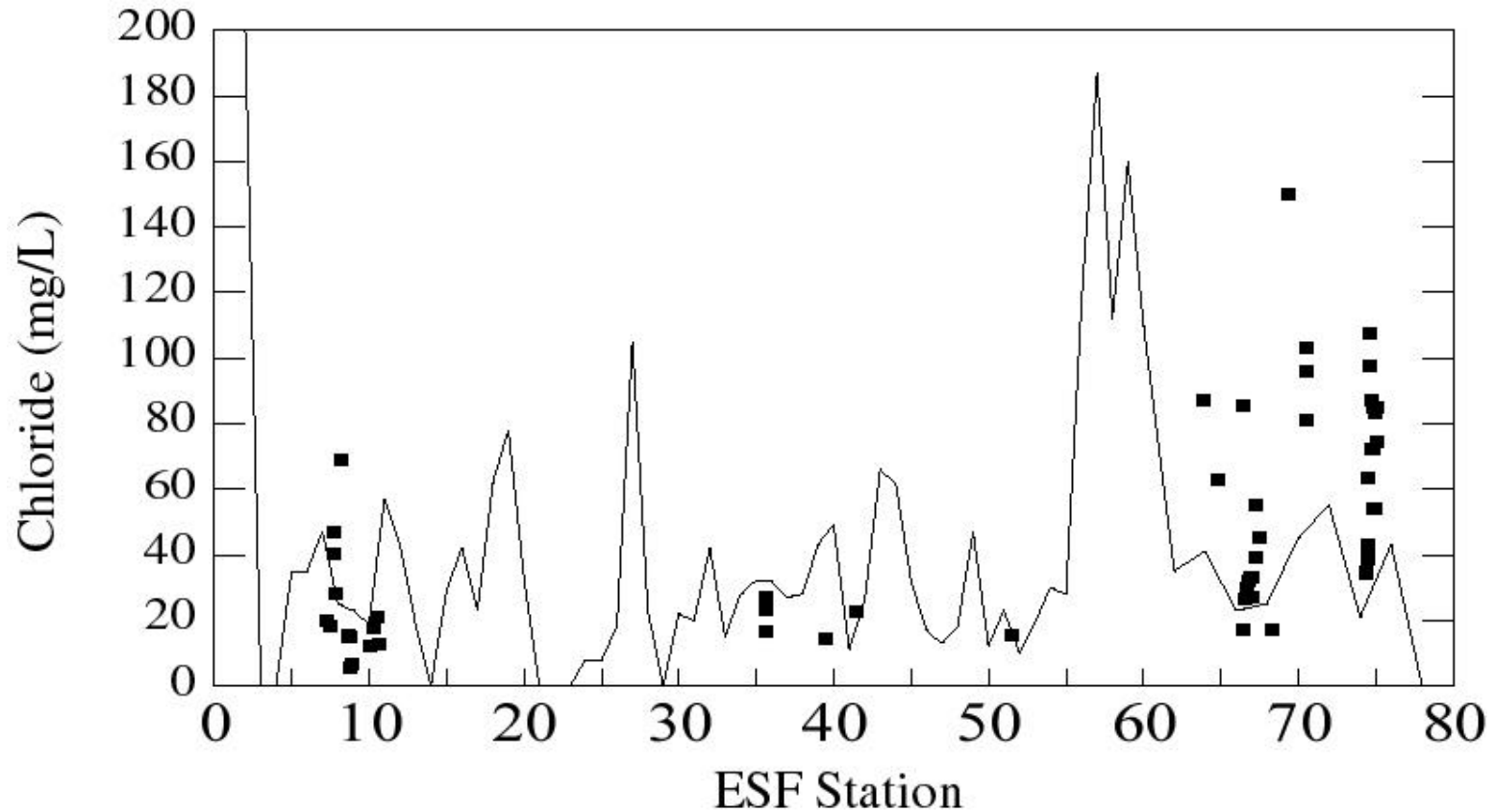
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**U.S. Department of Energy  
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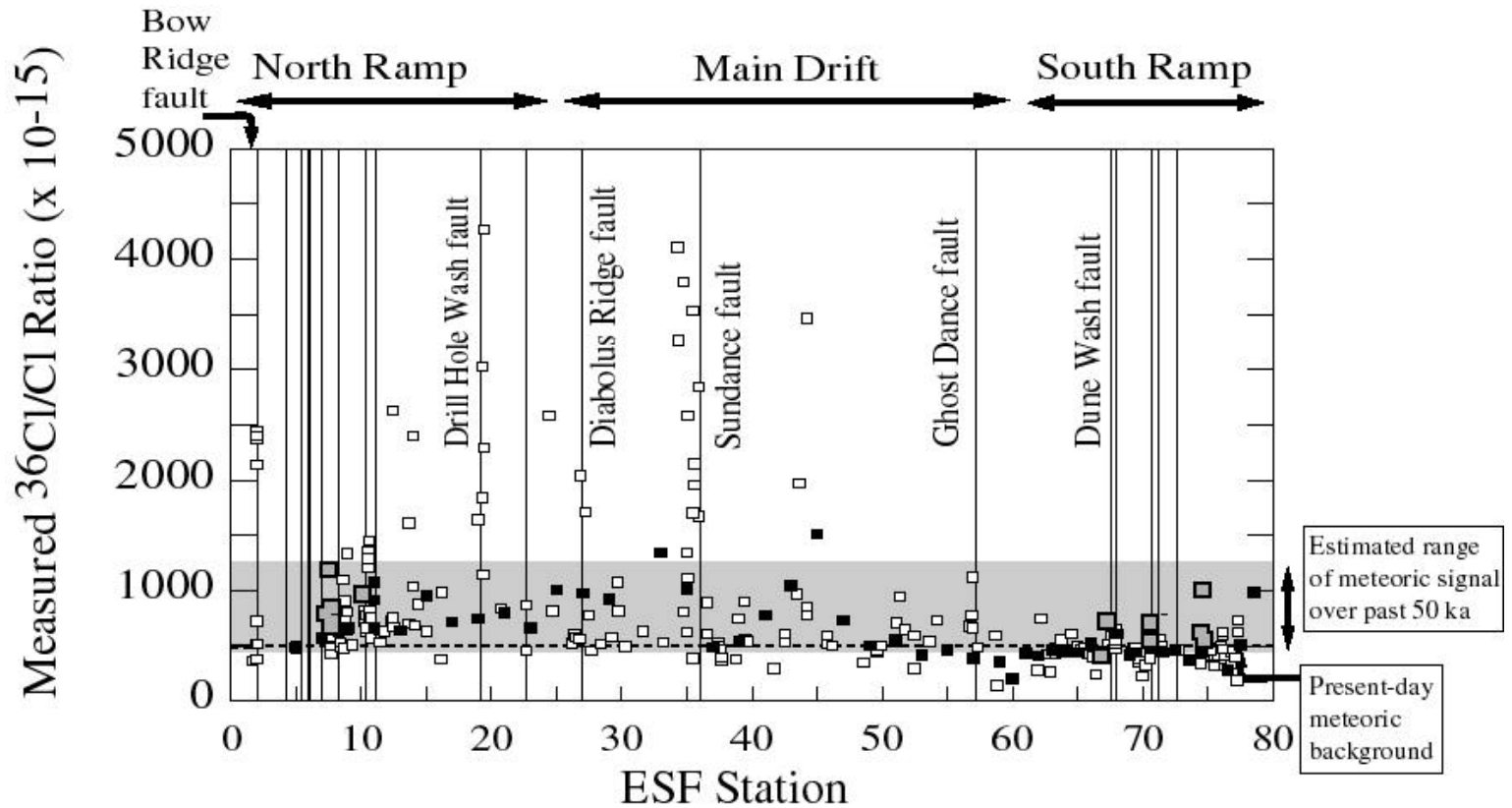
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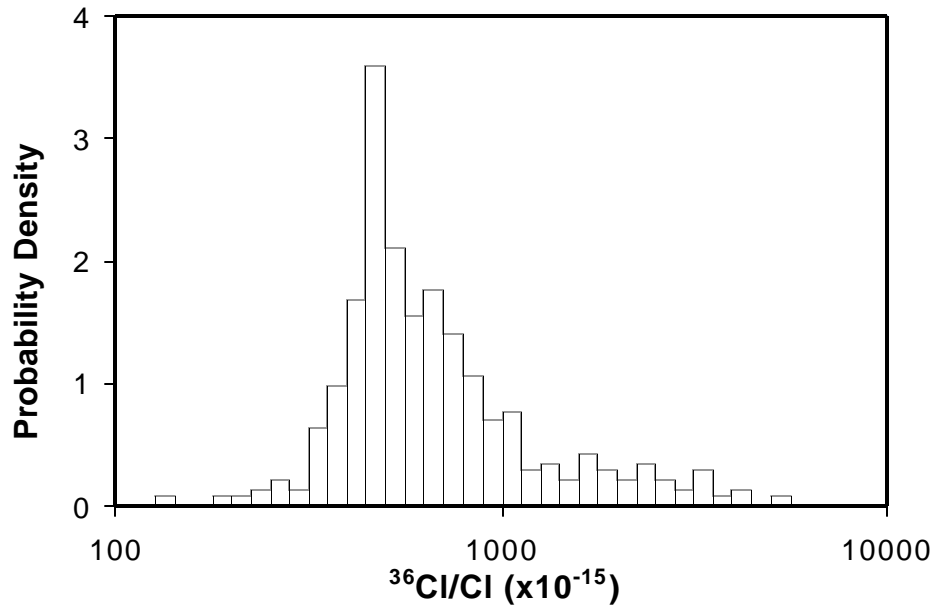
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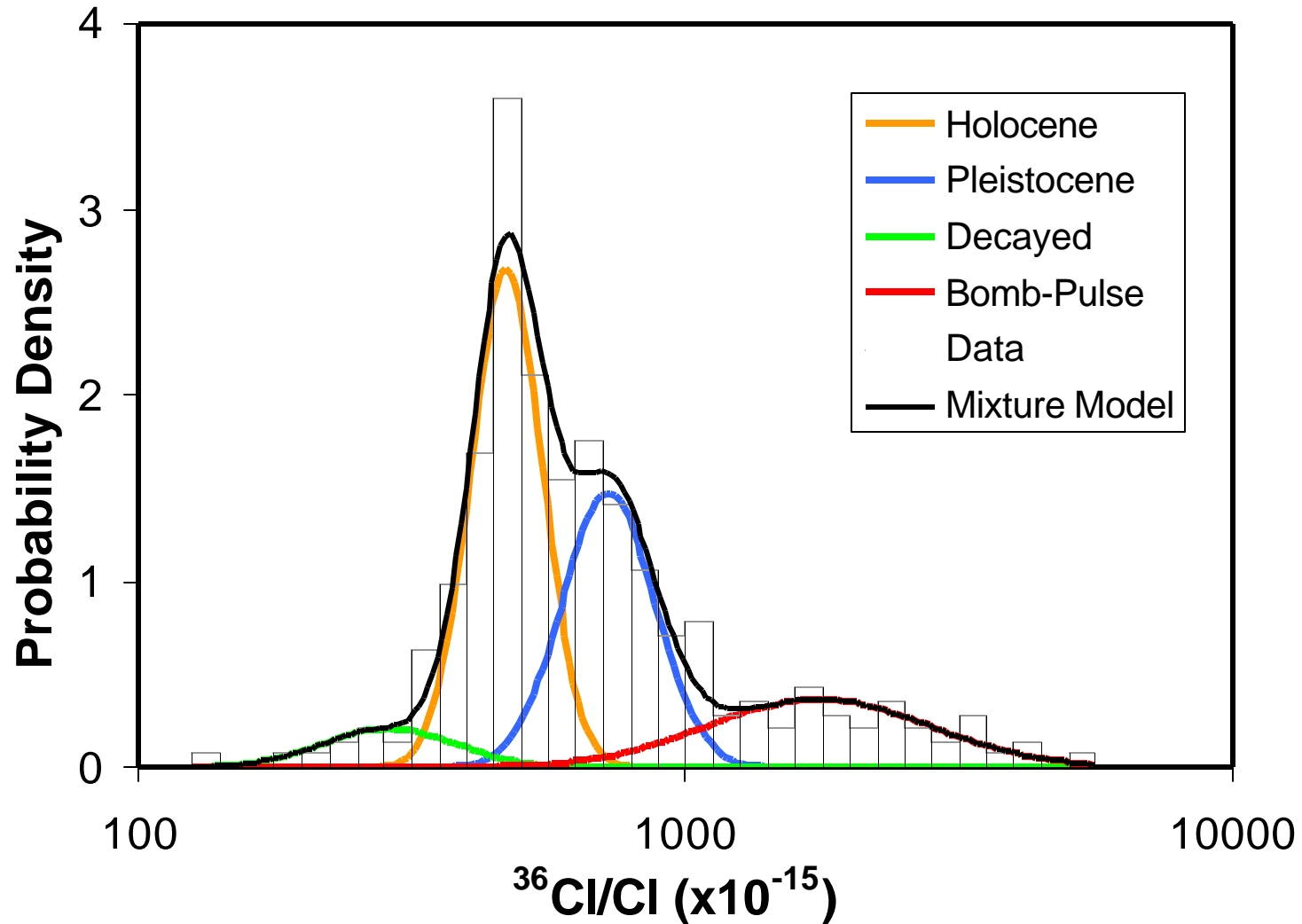
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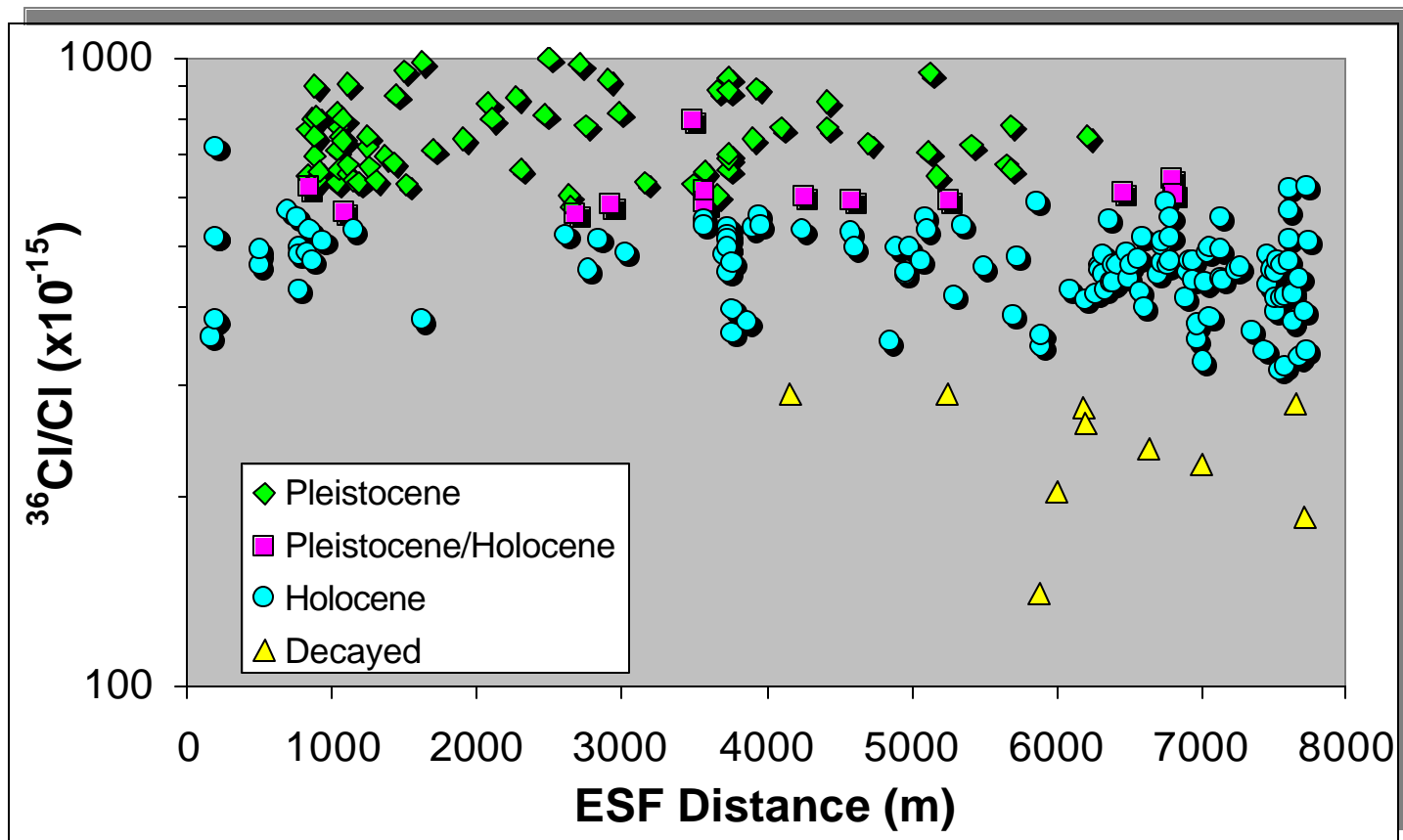
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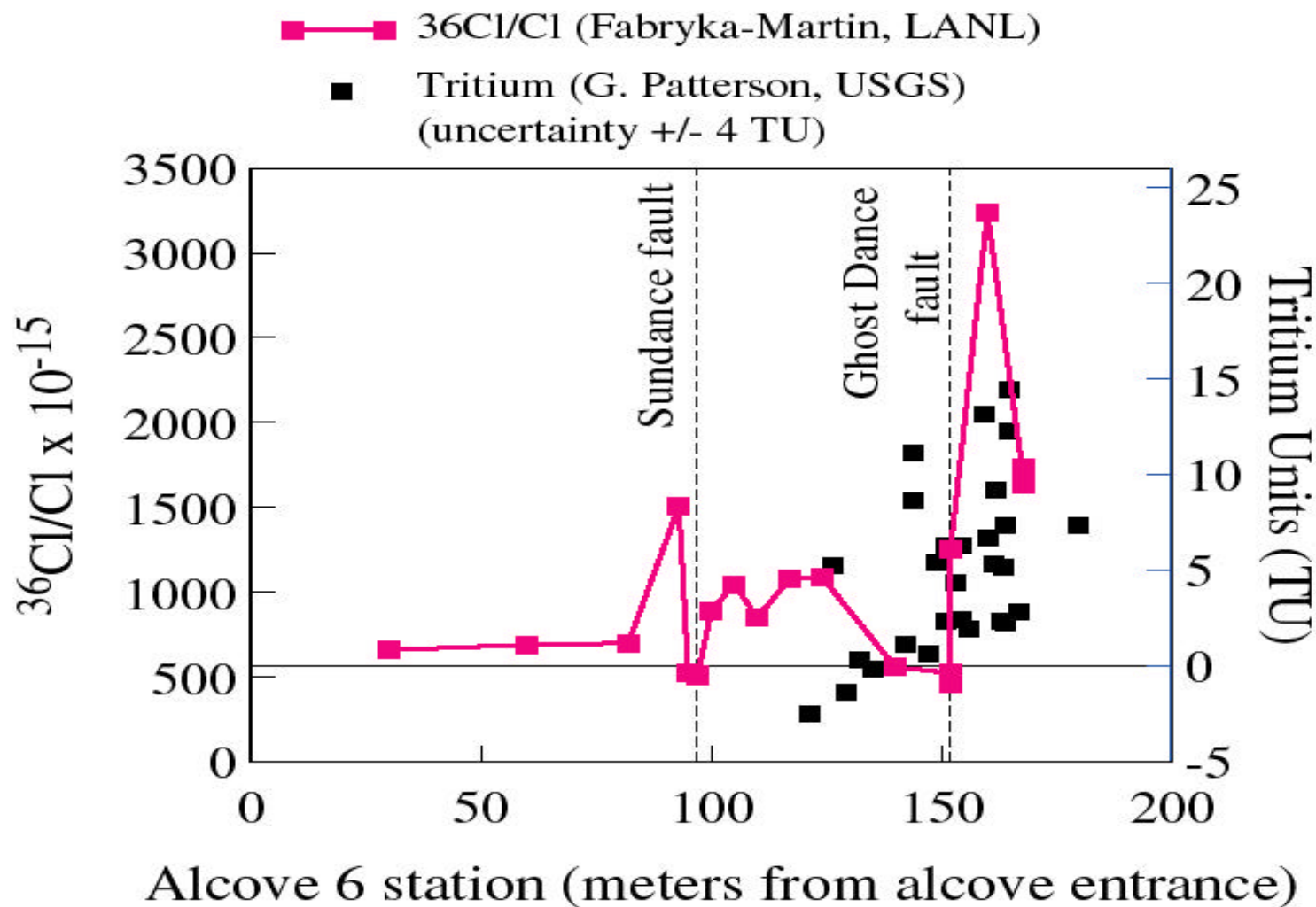
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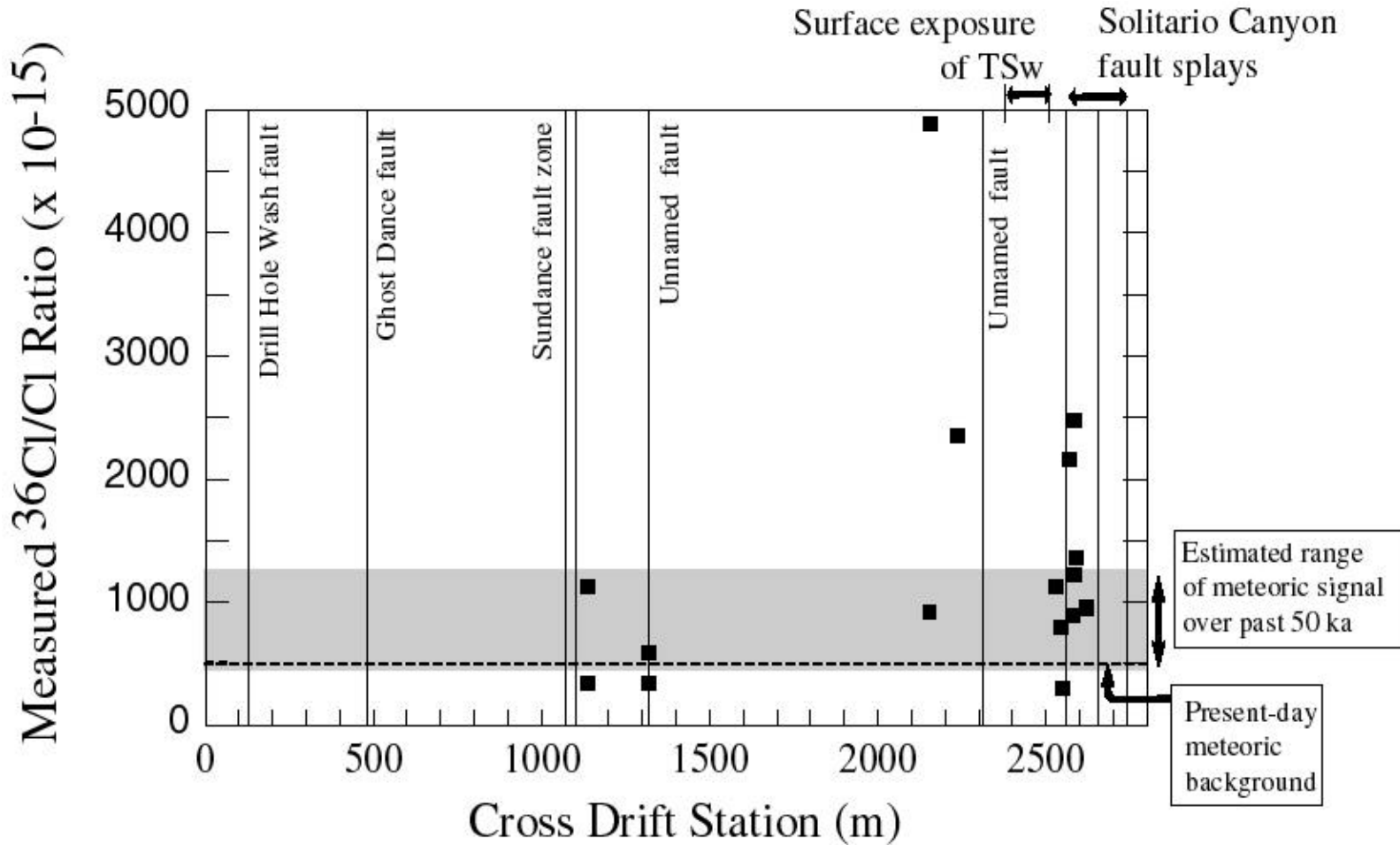
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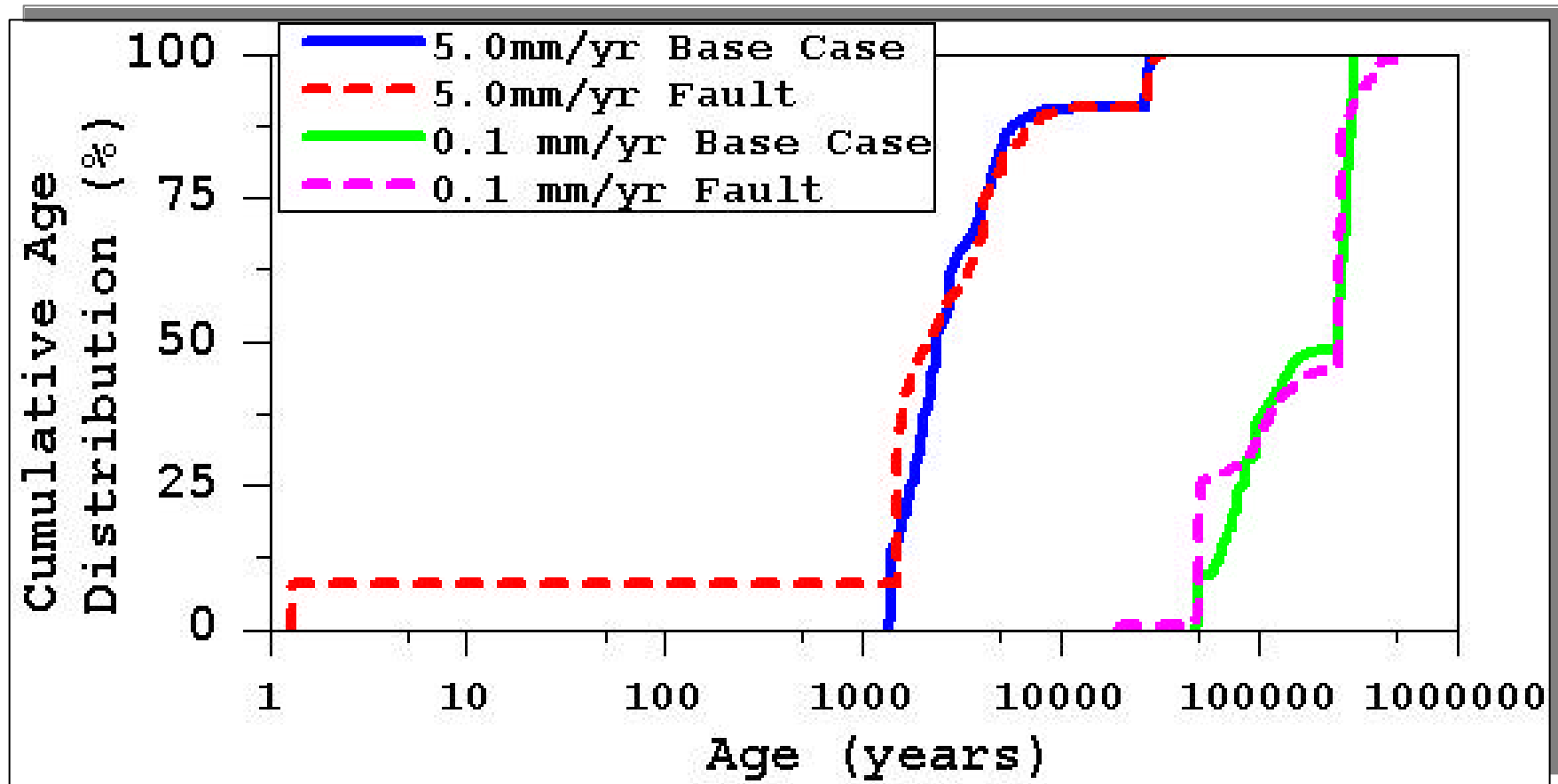
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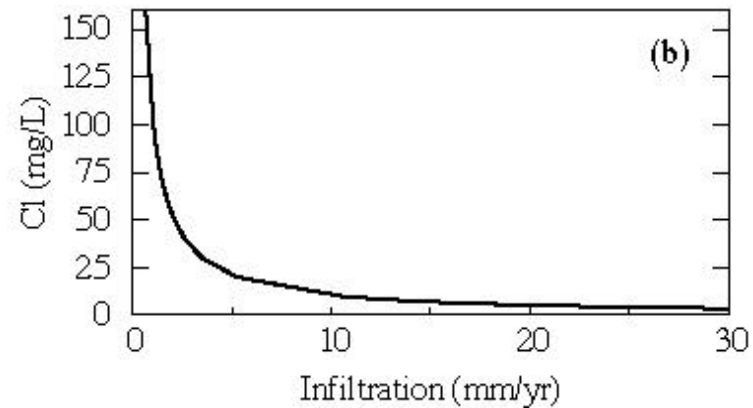
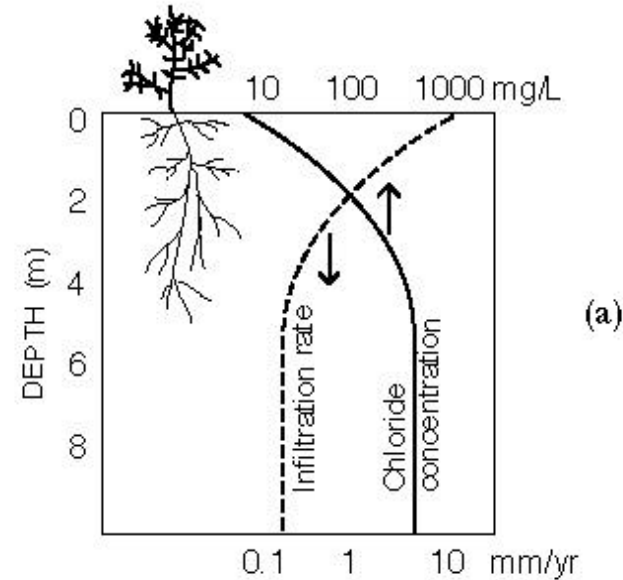
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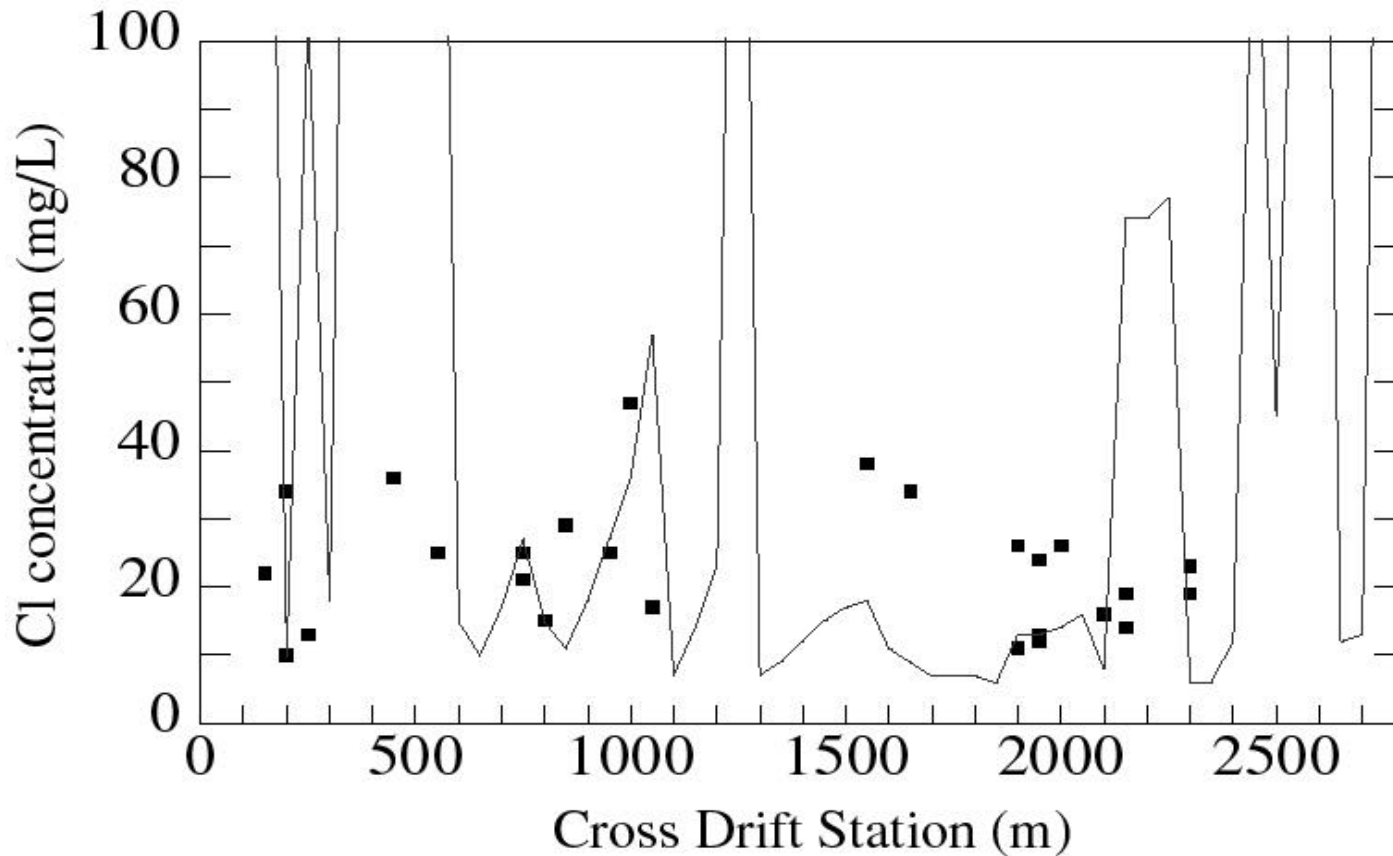
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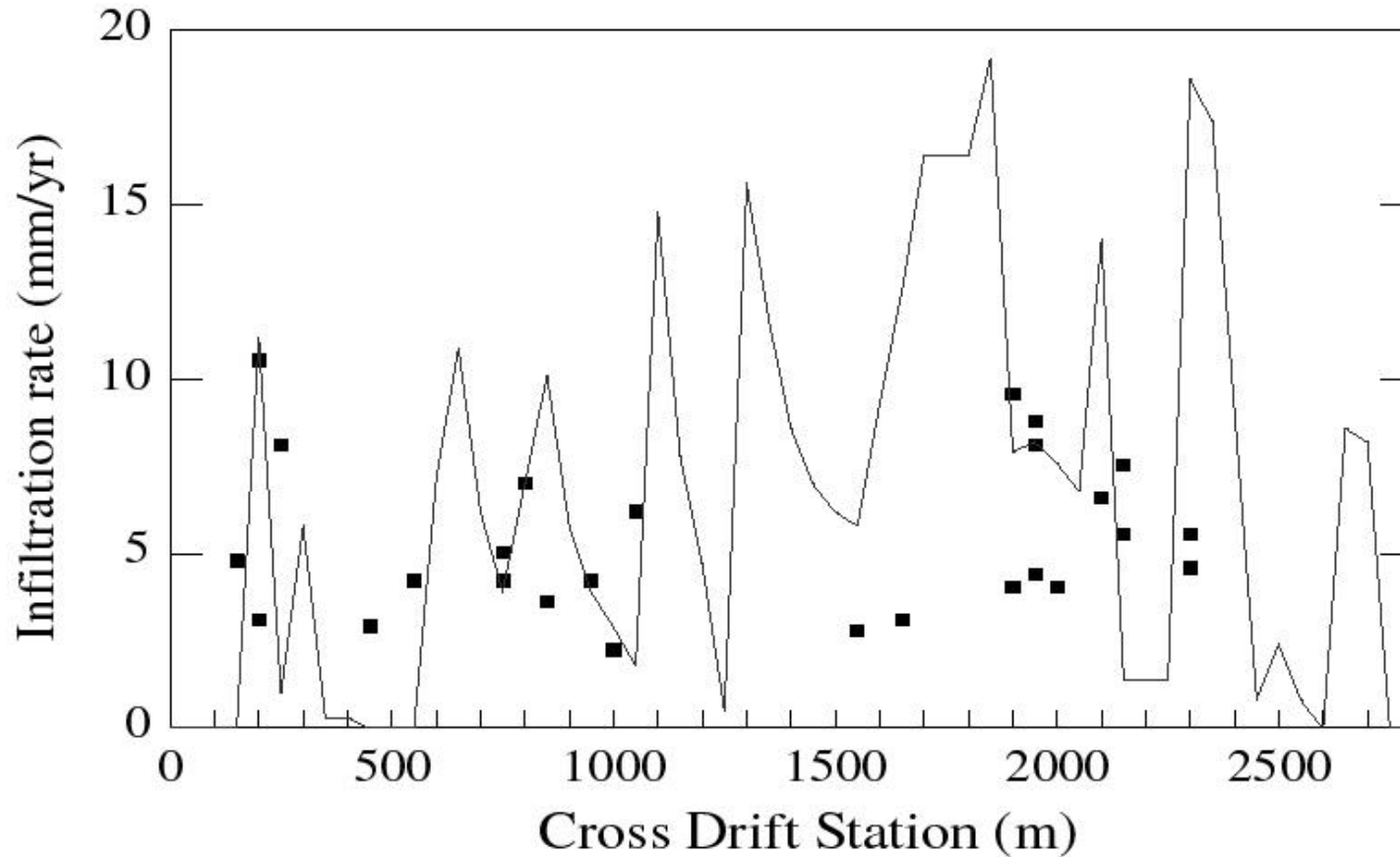
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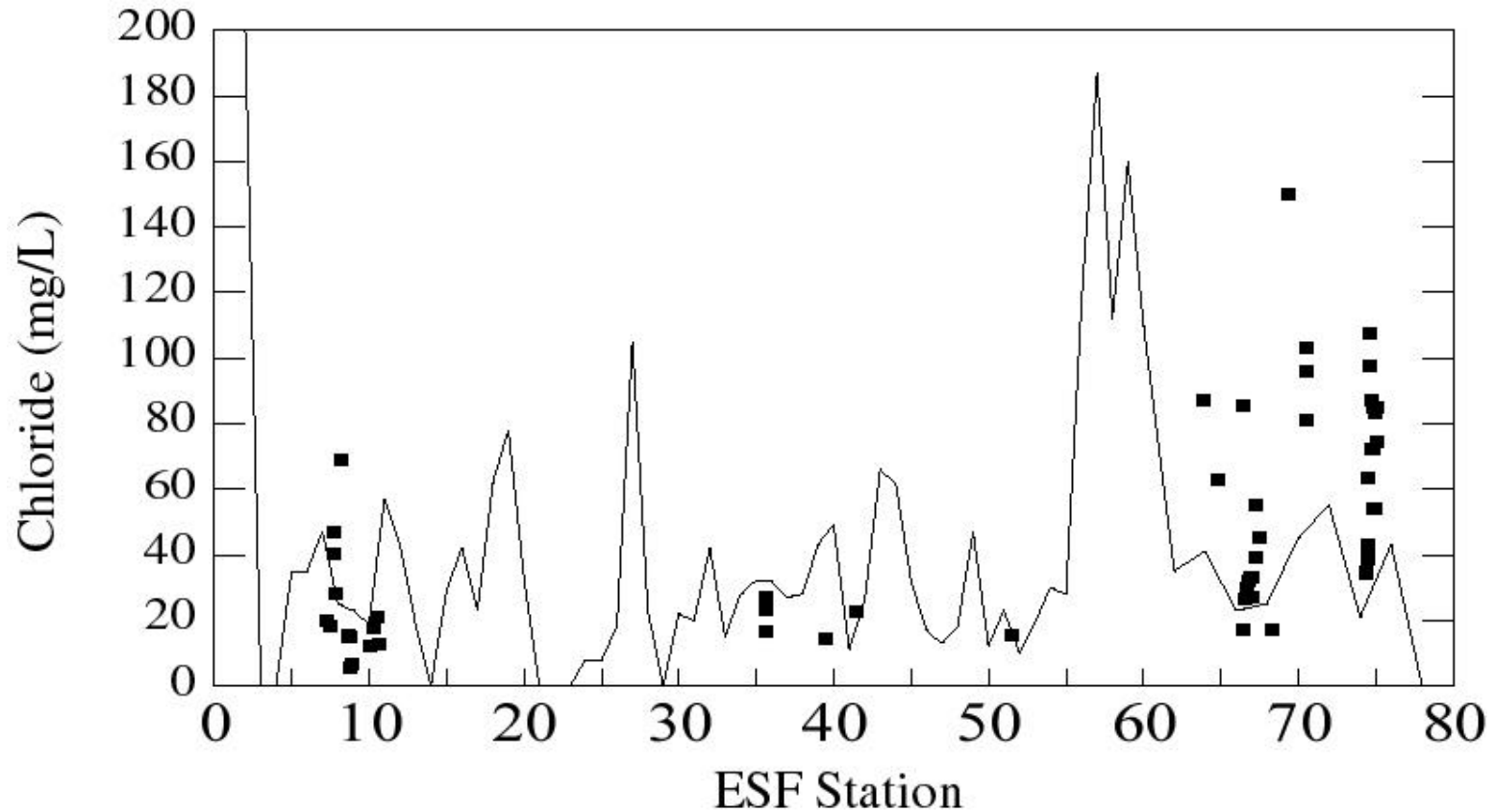
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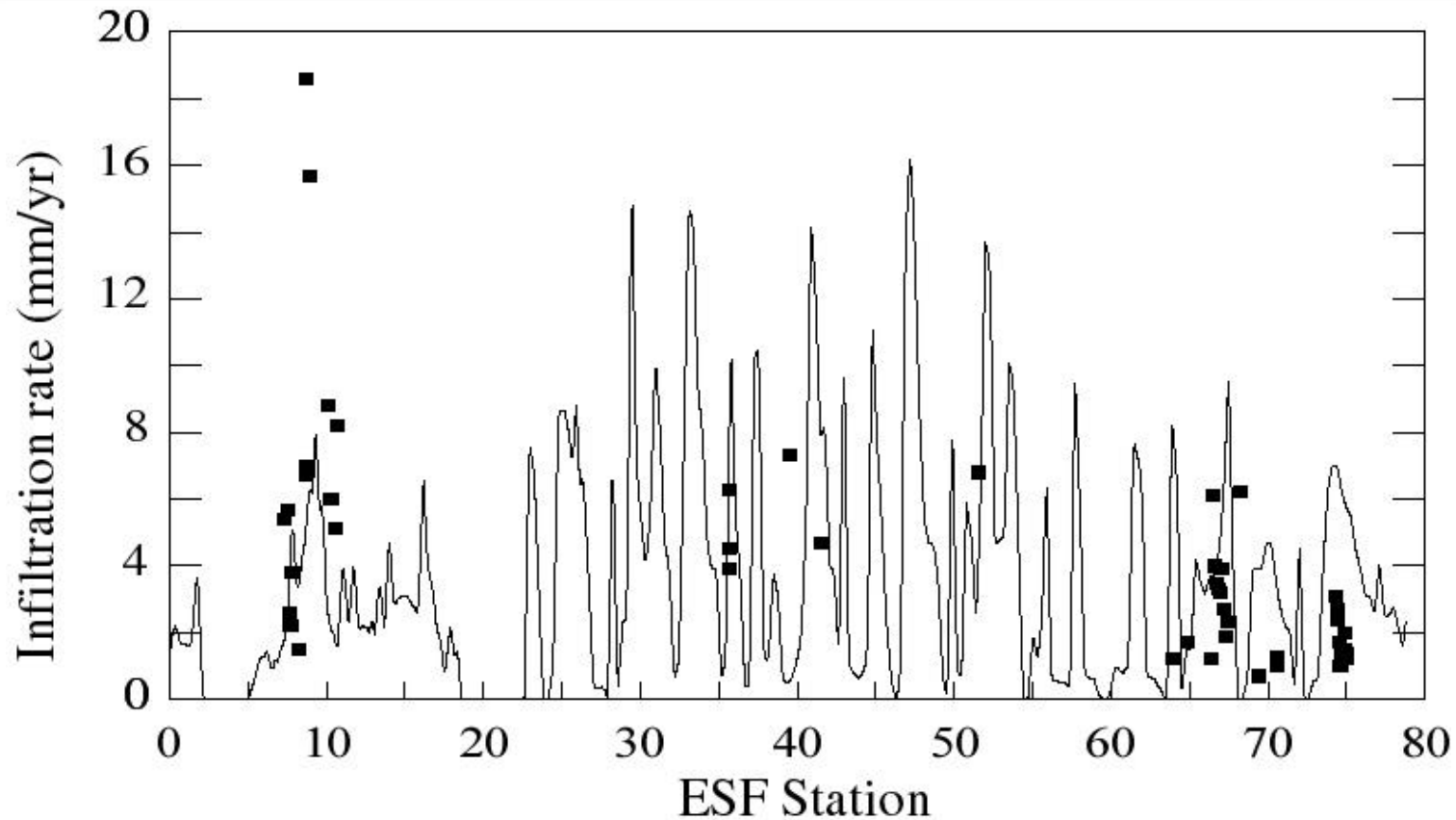
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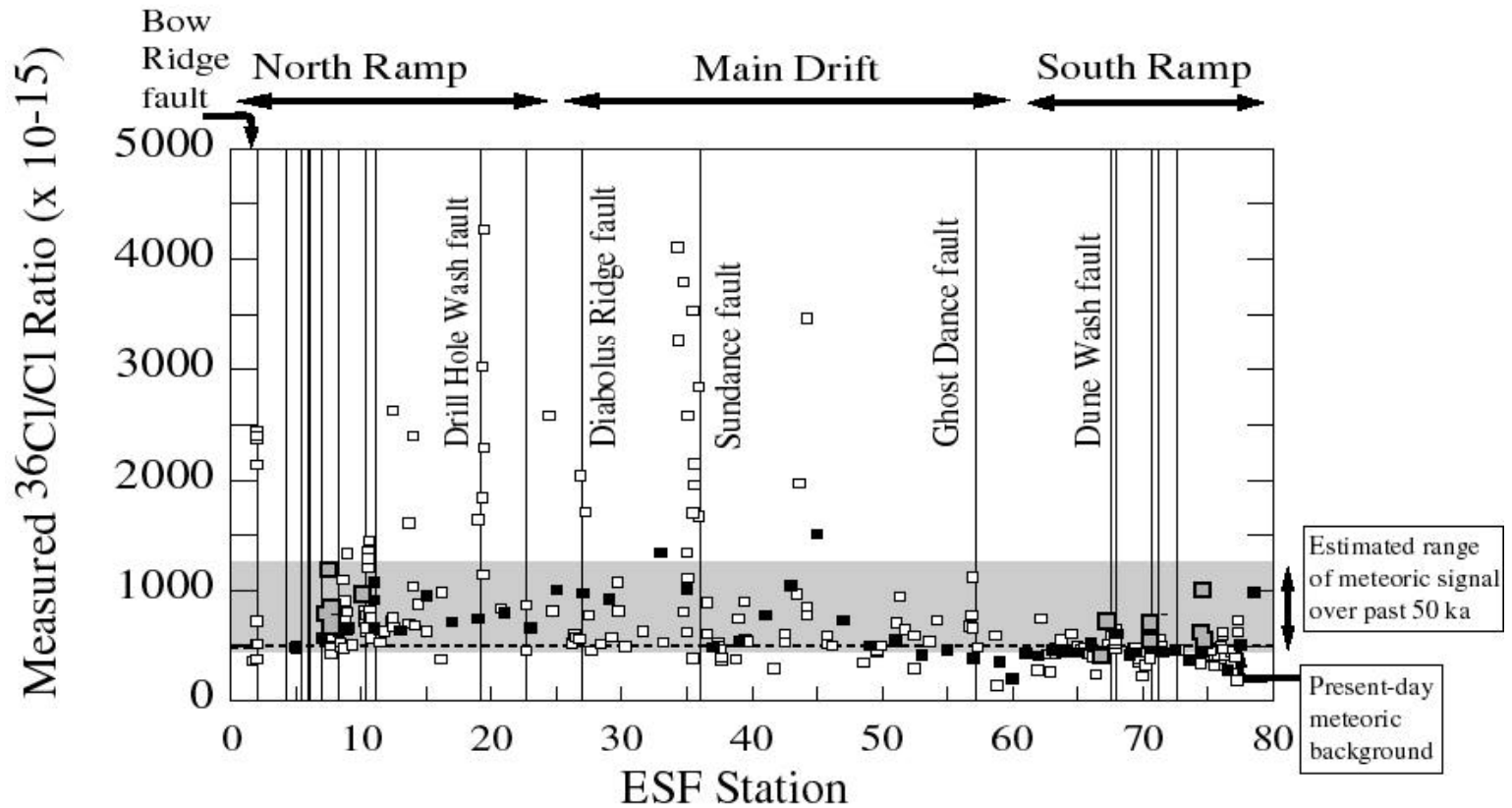
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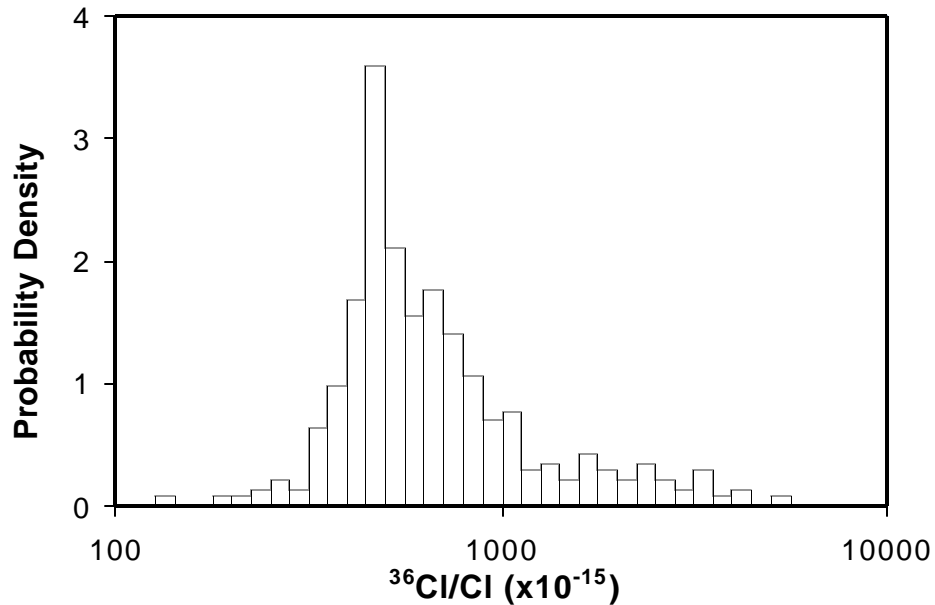
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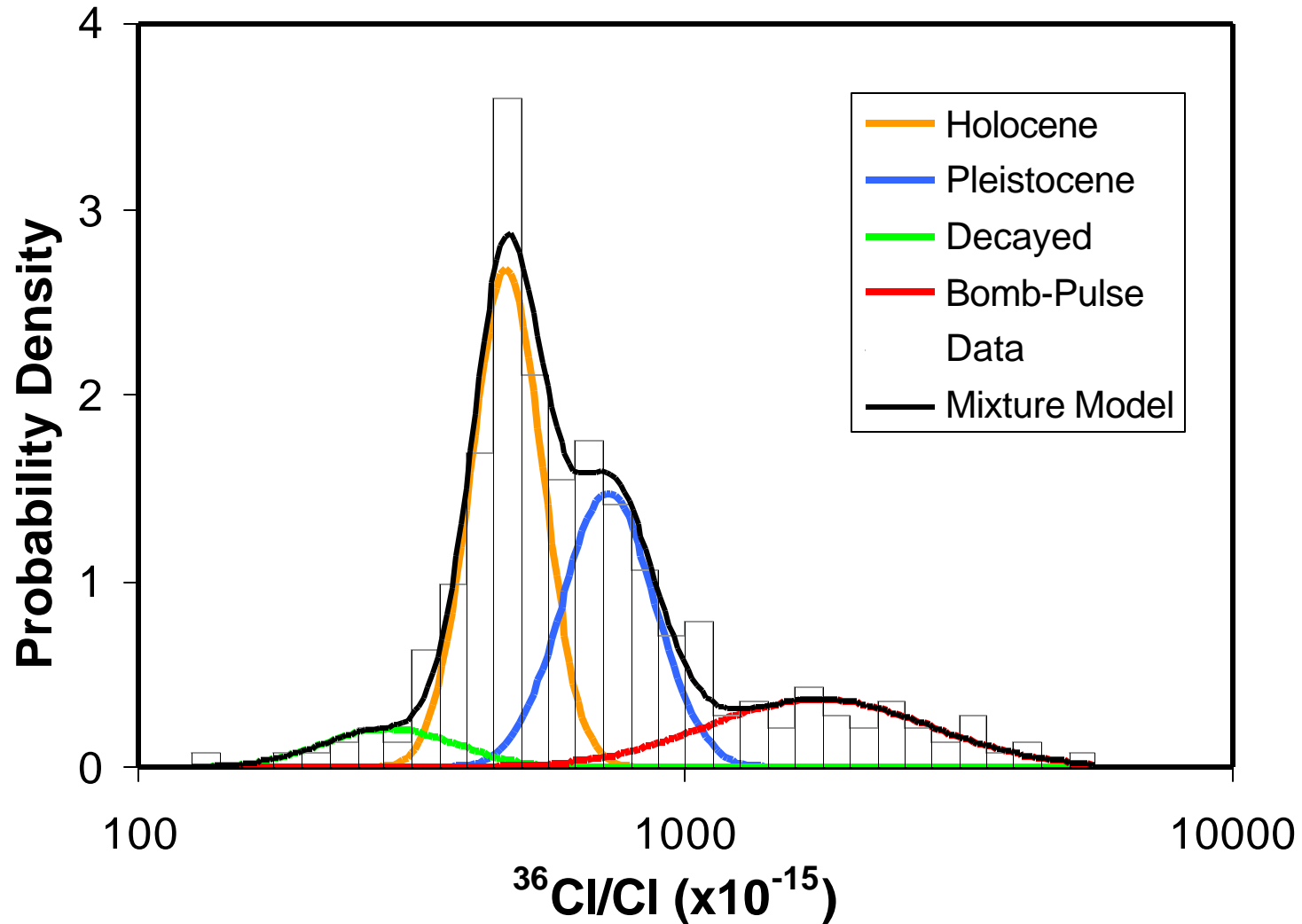
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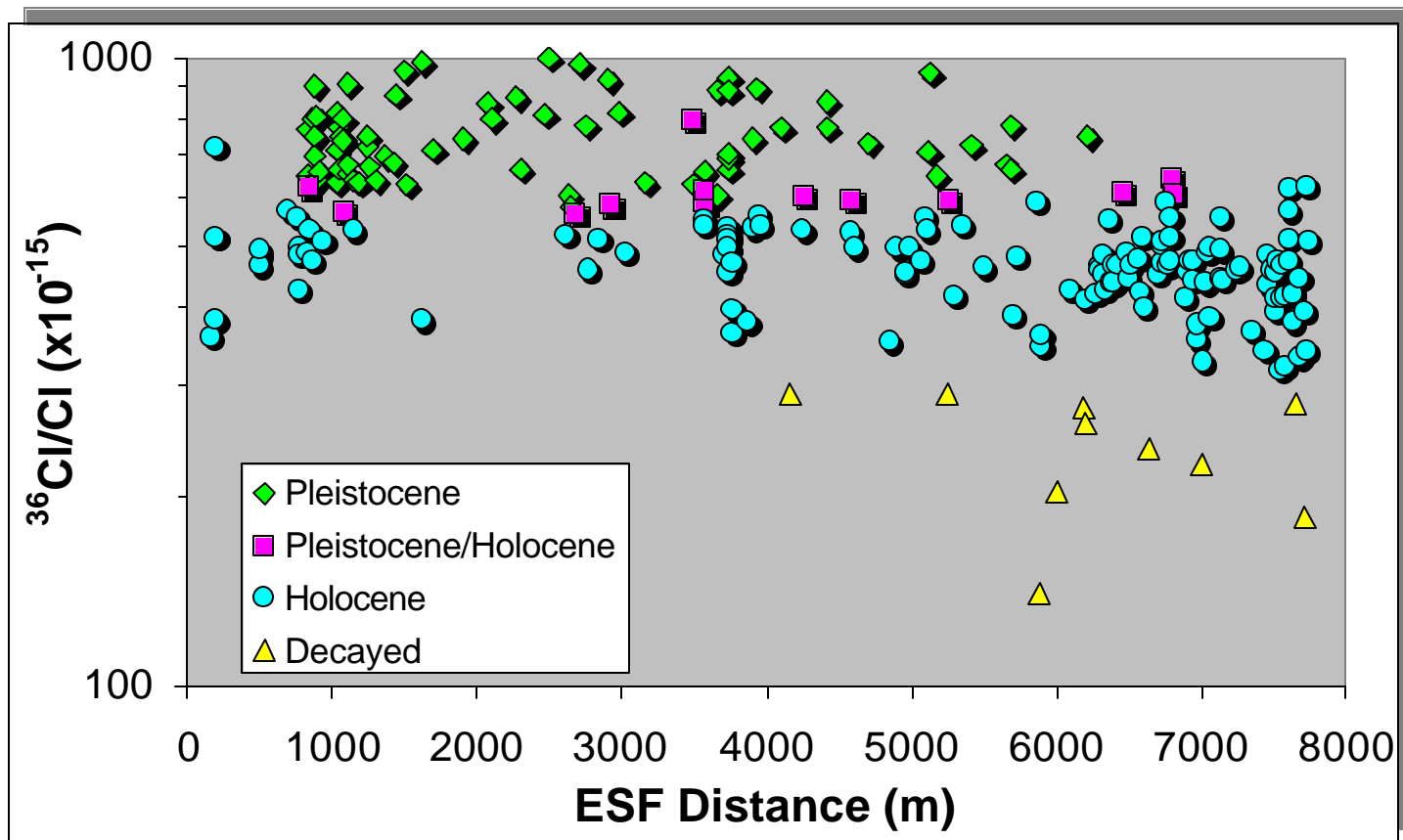


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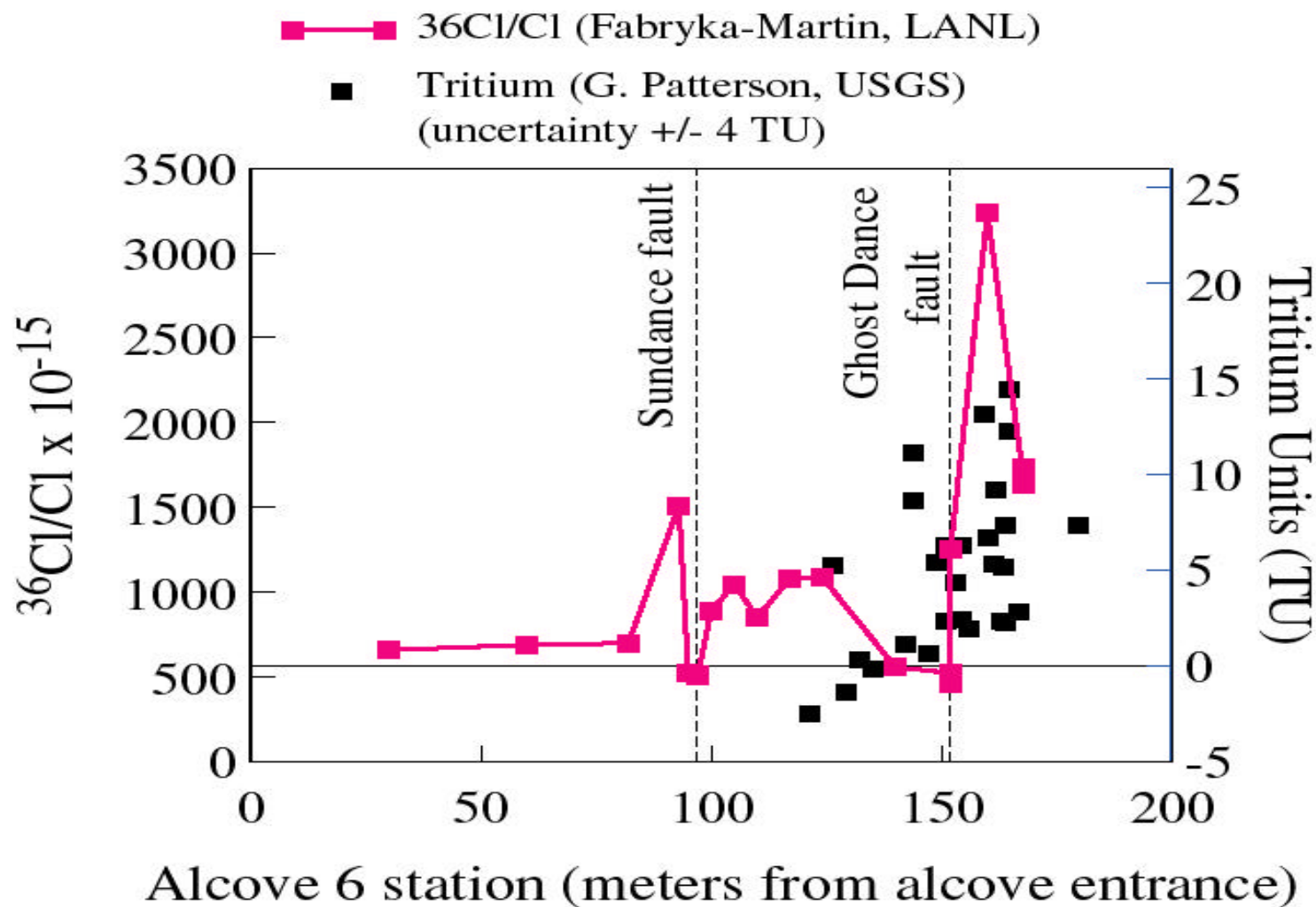


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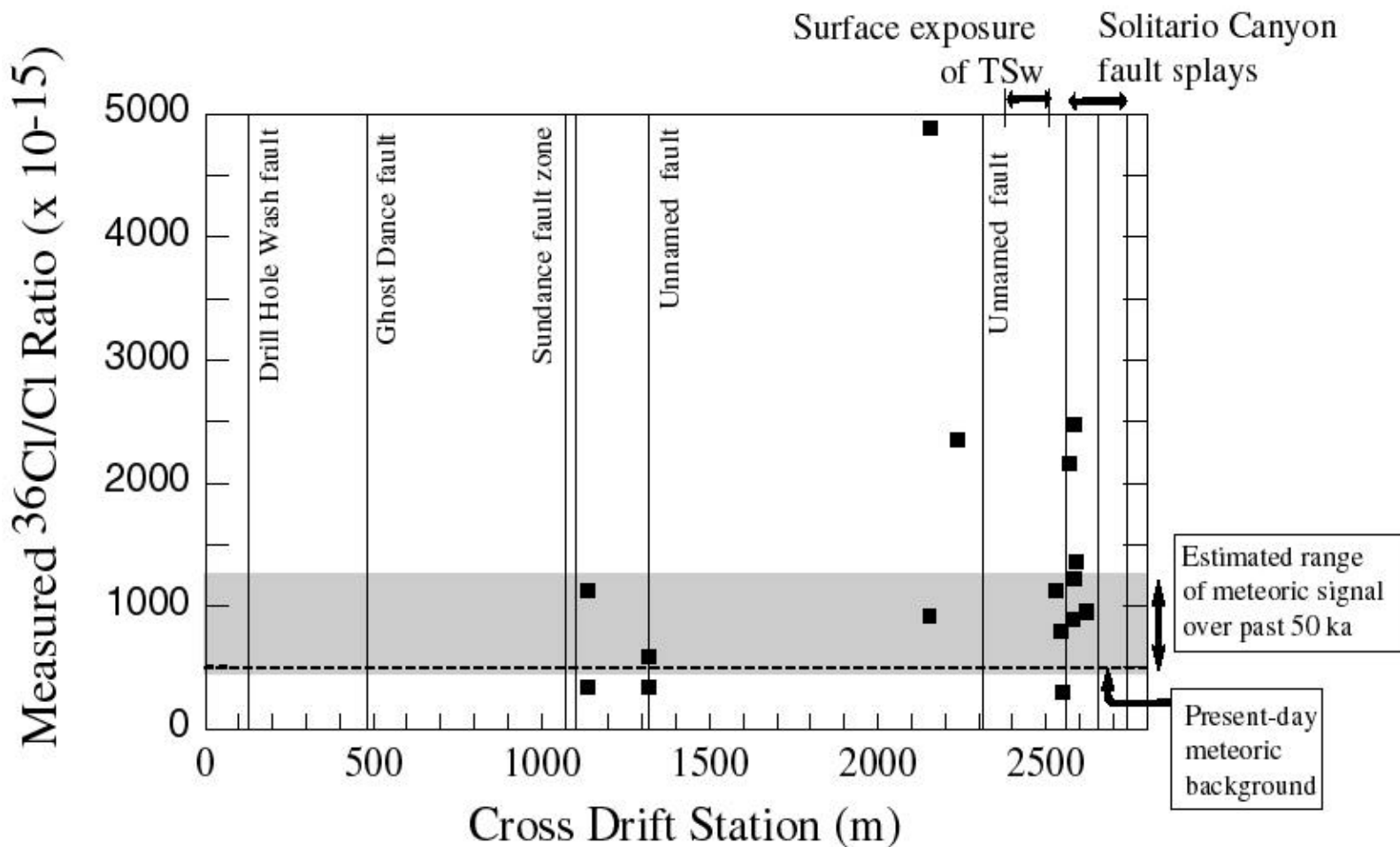




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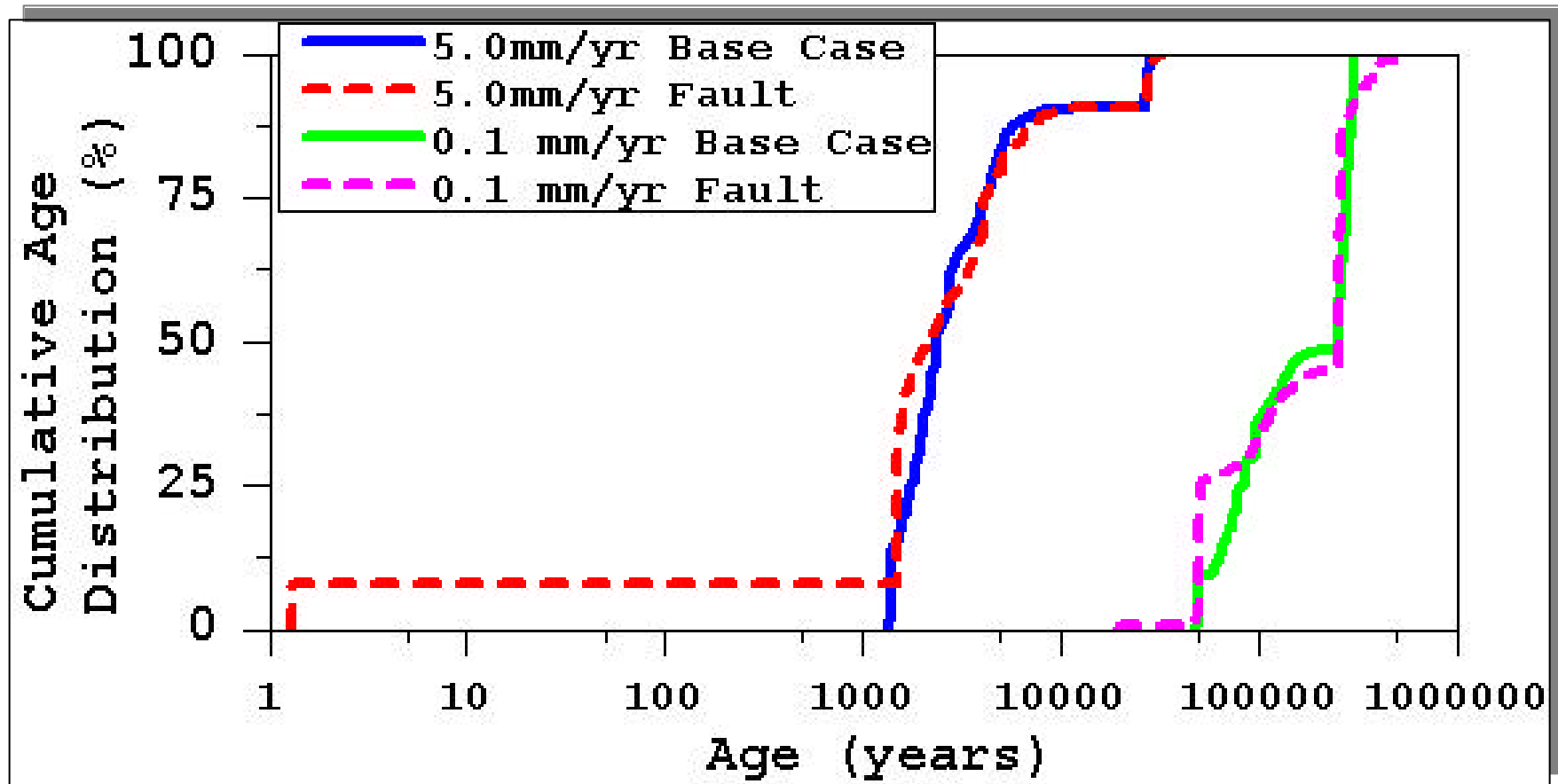
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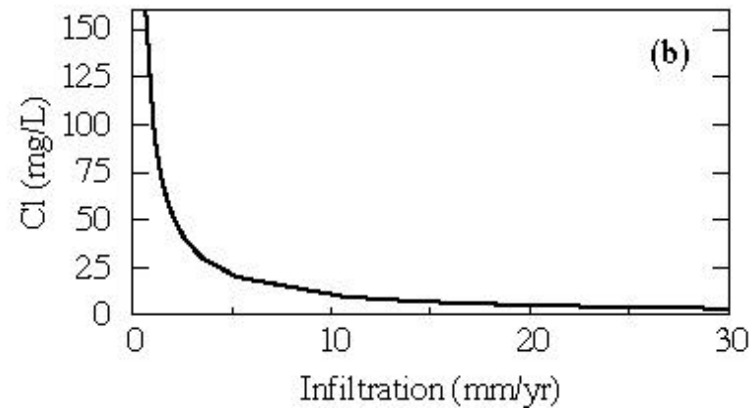
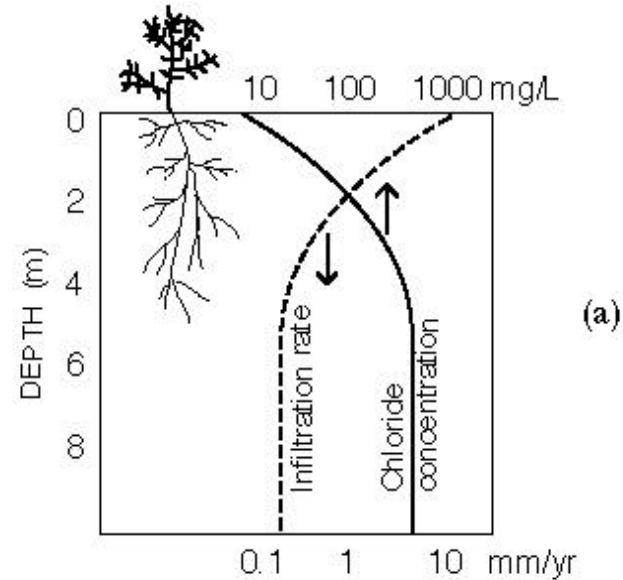
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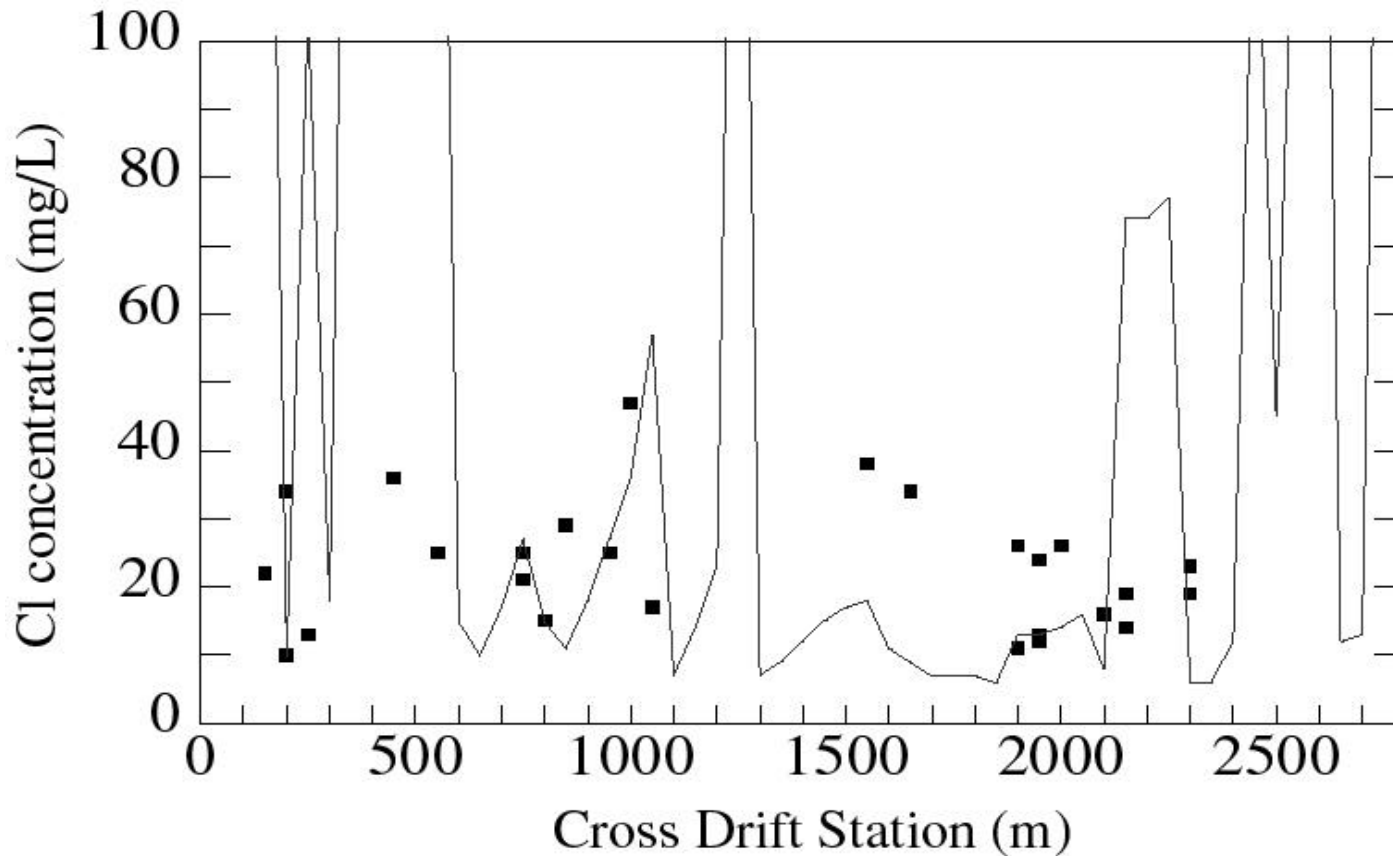


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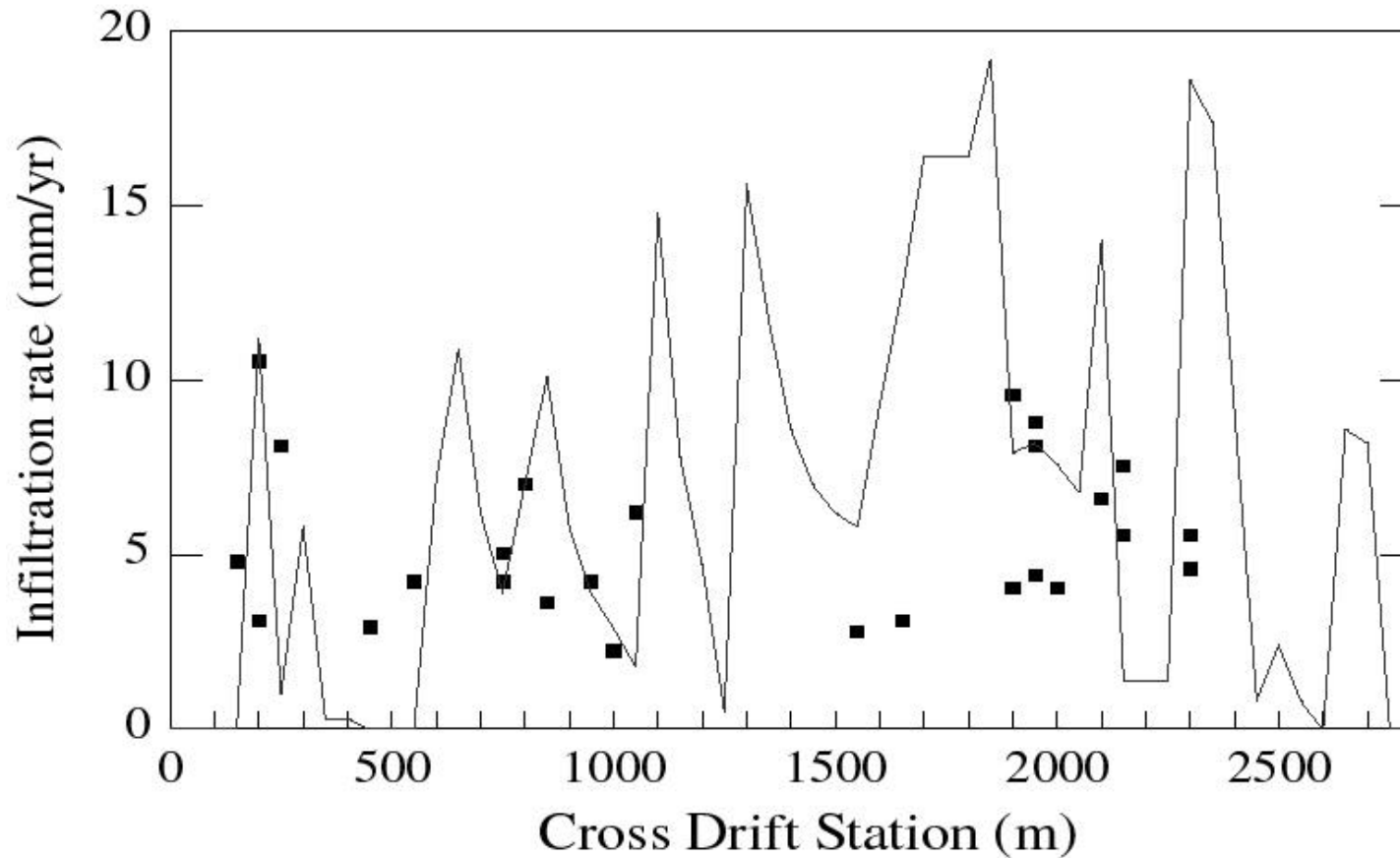
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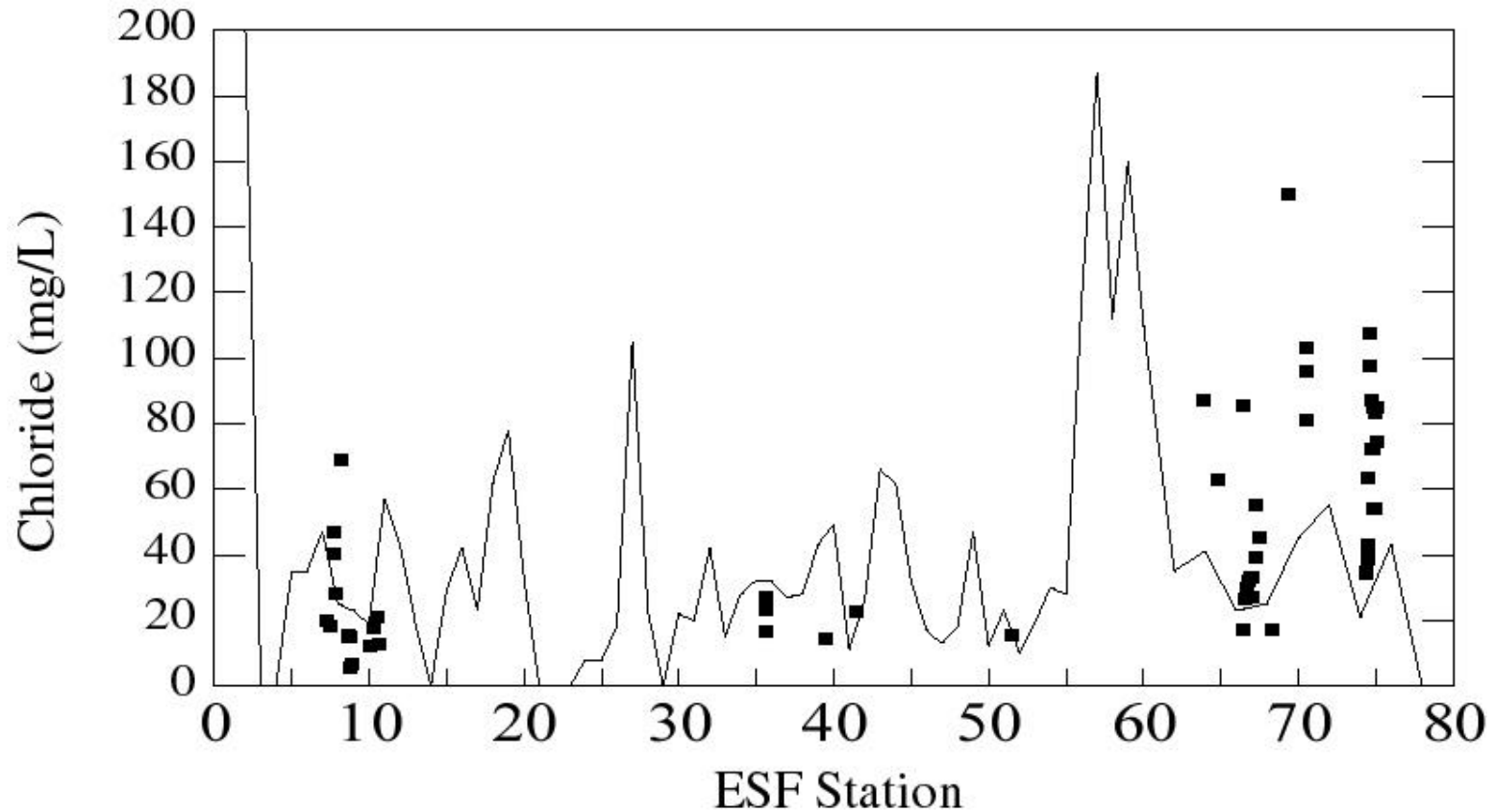
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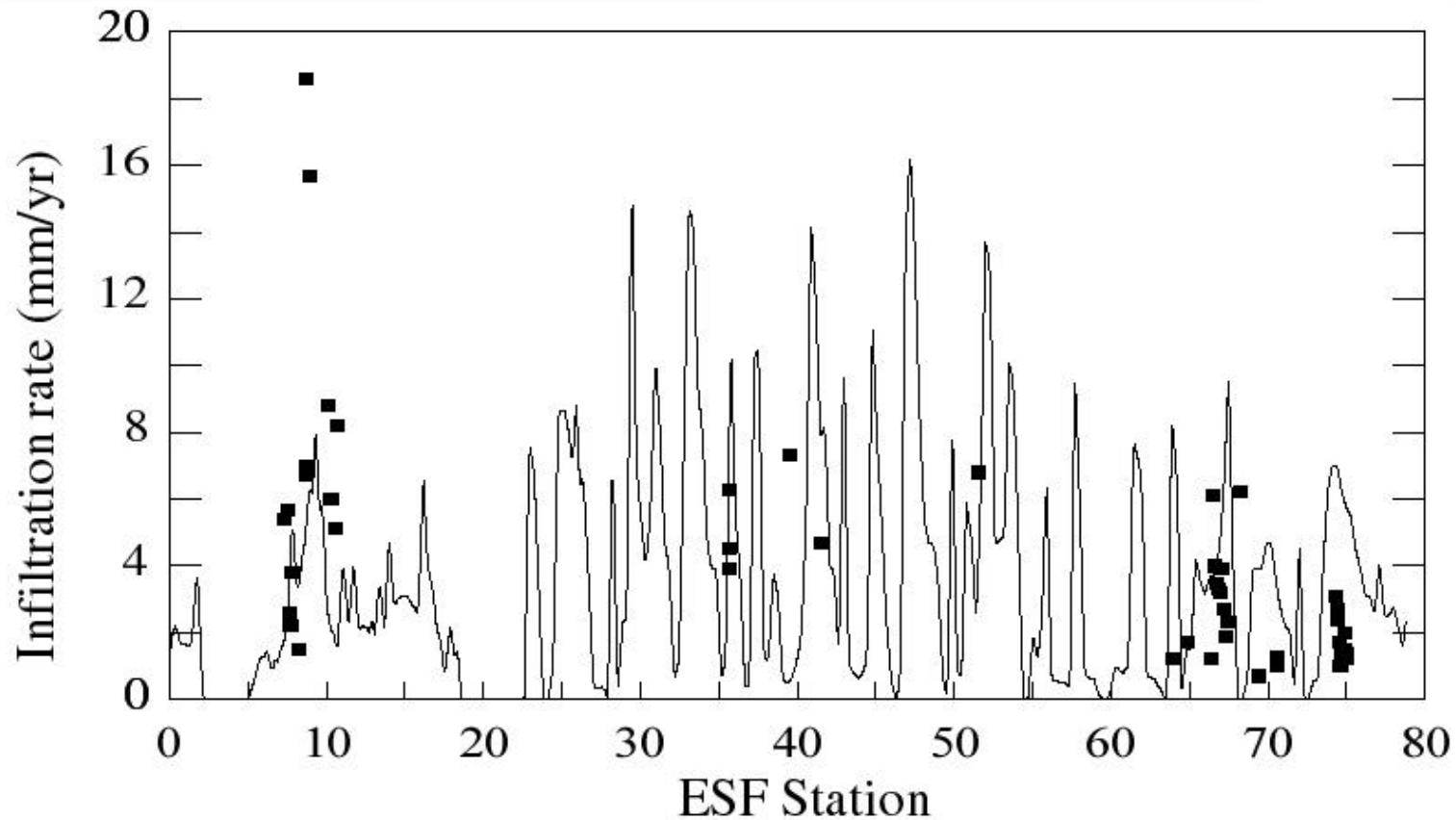


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