

# **NRC Perspective on the Risk Significance of Potential Consequences from Igneous Activity**

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# Outline

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- ◆ **Background Information**
- ◆ **Risk Significant Features, Events, and Processes for Igneous Activity**
- ◆ **Review Information for Areas of Significance to Performance, and Associated Concerns**
- ◆ **Conclusions**

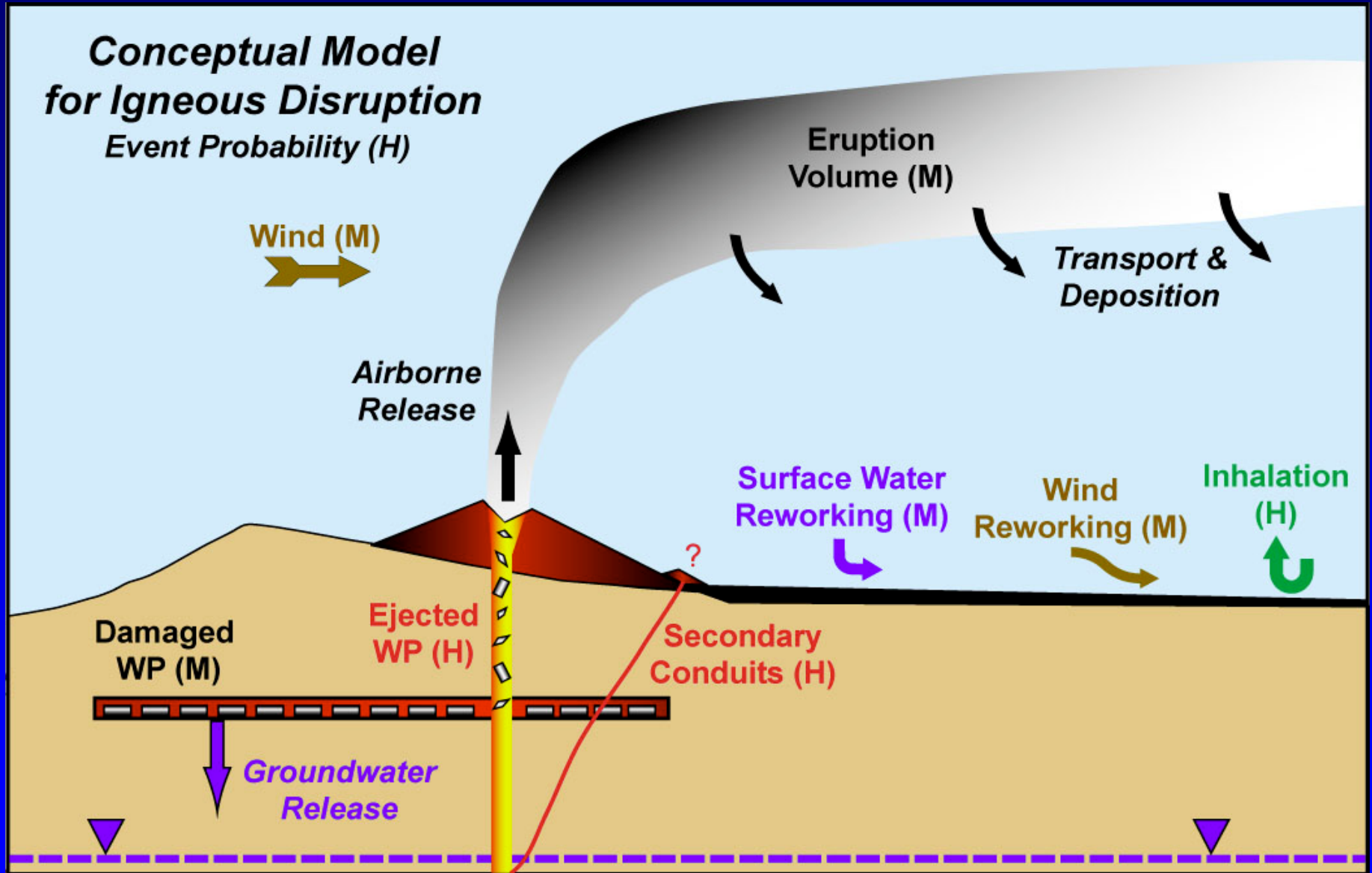


## Background

- ◆ **NRC conducted a range of independent investigations to develop review capabilities**
  - Unprecedented issues for potential consequence of igneous events
  - Information gaps in existing literature
  
- ◆ **NRC has not developed a “position” on igneous activity**
  - Independent information sometimes questioned DOE models in risk significant areas
  - DOE has often modified models or approaches in response to staff questions
  - Staff will consider a full range of information during LA review
  - Review will focus on the risk significant aspects of the DOE safety analysis report



# Risk Significant Aspects of Igneous Activity

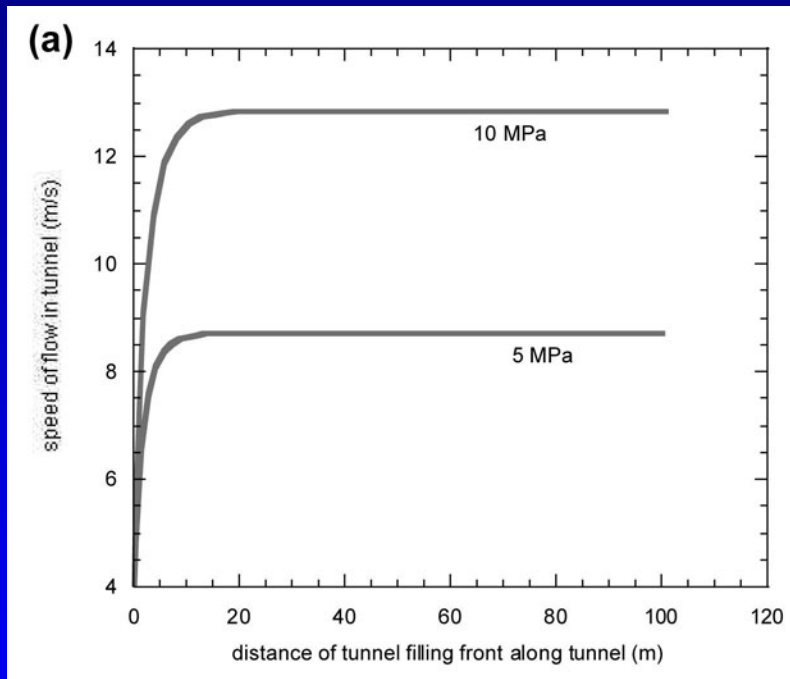


Based on NRC (2004)

Hill, ACNW 2/14/07, p. 4



# Magma-Drift Interactions



*Lejeune et al. (2002)*

- ◆ Risk (M): How far might magma flow into drifts?
- ◆ Information from numerical and experimental models
- ◆ Information shows if magma intersects drifts, it will depressurize, flow rapidly, and fill intersected drifts with molten magma approximately 1-5 minutes after intersection
- ◆ Effects of alternative models straightforward to review

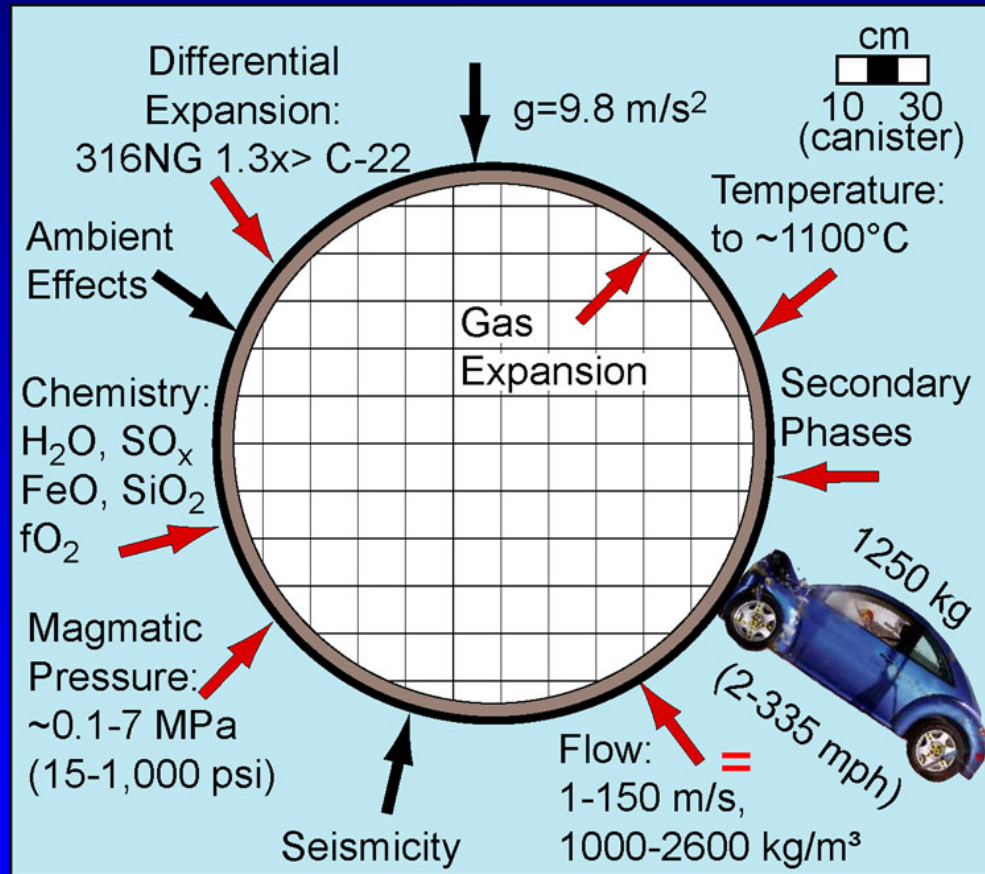


## Highlight of Concerns with ACNW Draft White Paper

- ◆ **Draft white paper does not cite or discuss important NRC information on magma-drift interactions**
  - **Degassed magma flow**
  - **2-phase flow in dikes**
  - **Magma ascent**
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Limitations in alternative models (e.g., observations that depressurized magmas flow  $>0.7$  km [0.4 mi] at surface) not addressed**



# Waste Package Response to Magma



Based on NRC (2005)

- ◆ Risk (H): Will package fail if exposed to magma?
- ◆ Multiple lines of information for package response to magma
- ◆ Information shows combined thermal and mechanical effects from sustained (days) magmatic exposure exceed design capacity of waste packages
- ◆ Alternative information does not increase dose significantly



## Highlight of Concerns with ACNW Draft White Paper

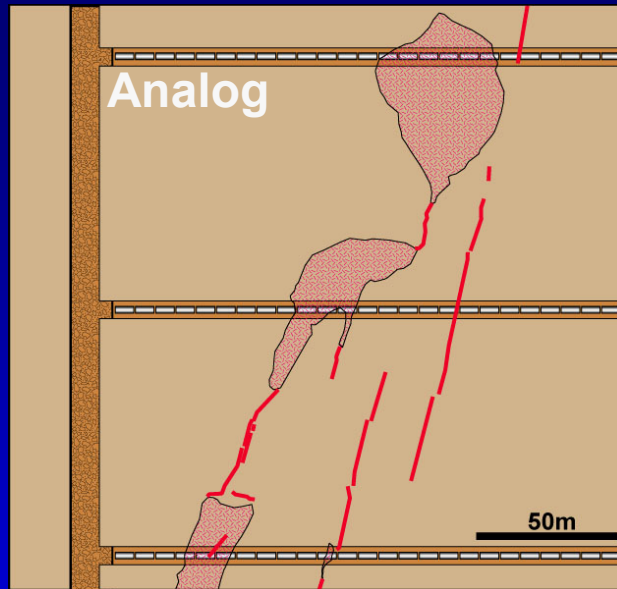
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- ◆ **Draft white paper does not cite or discuss important NRC information on waste package response to magma conditions**
  - **Materials properties**
  - **Coupled igneous processes**
  
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
  
- ◆ **Limitations in alternative models (e.g., lack of coupling for thermal and mechanical effects) not addressed**

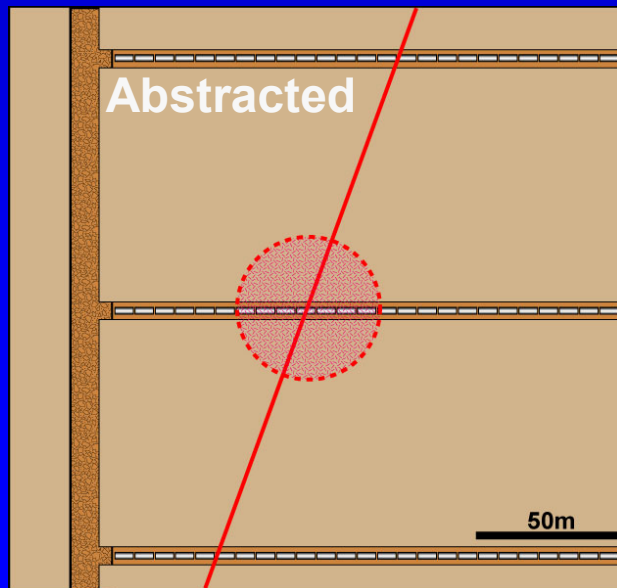




# Volcanic Conduit Formation



Based on Hill et al. (1999)



- ◆ Risk (H): How many waste packages entrained in eruption?
- ◆ Information from analog volcanoes
- ◆ Information shows conduits widen progressively during eruptions and would intersect hot, breached waste packages
  - effective diameters of 5-50 m [16-164 ft]
- ◆ Effects of alternative models straightforward to review



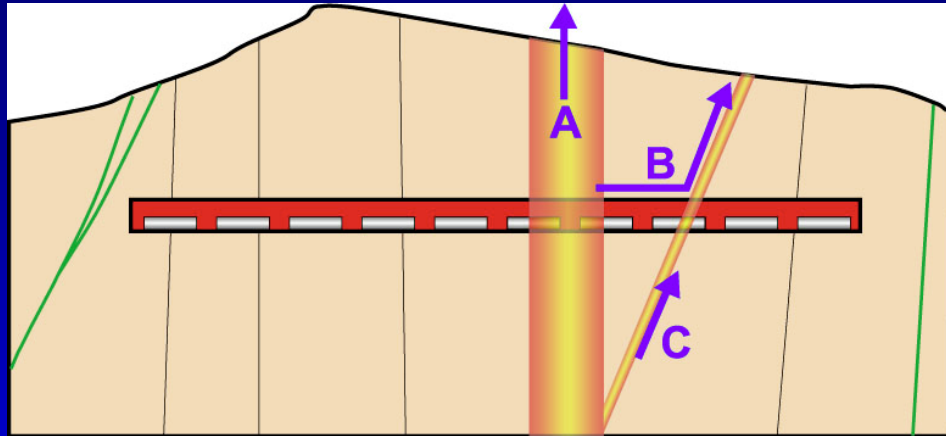
## Highlight of Concerns with ACNW Draft White Paper

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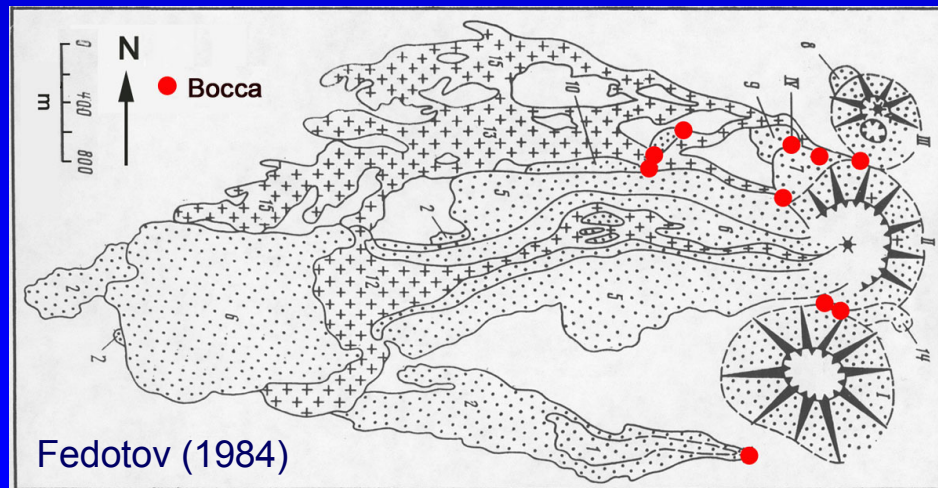
- ◆ **Draft white paper does not cite or discuss important NRC information on conduit development**
  - Magma ascent and flow
  - Field observations
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Alternative information not addressed**



## Formation of Secondary Breakouts



Based on Woods et al. (2002, 2005)



- ◆ Risk (H): Could secondary breakouts release more waste than a single conduit?
- ◆ Information from analogs and models to consider an alternative conceptual model
- ◆ Secondary breakouts may occur because of repressurization effects during eruption, not shock effects from initial flow
- ◆ Effects of alternative information can be reviewed



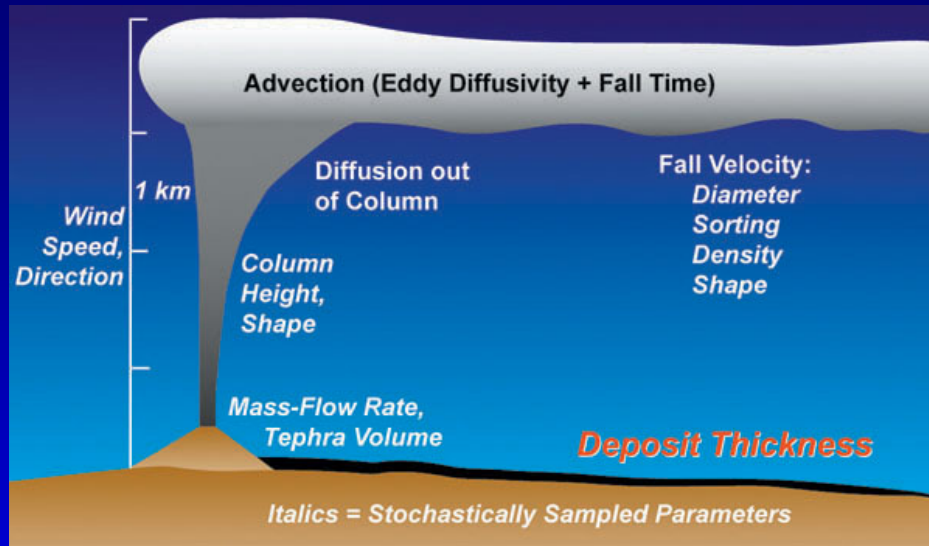
## Highlight of Concerns with ACNW Draft White Paper

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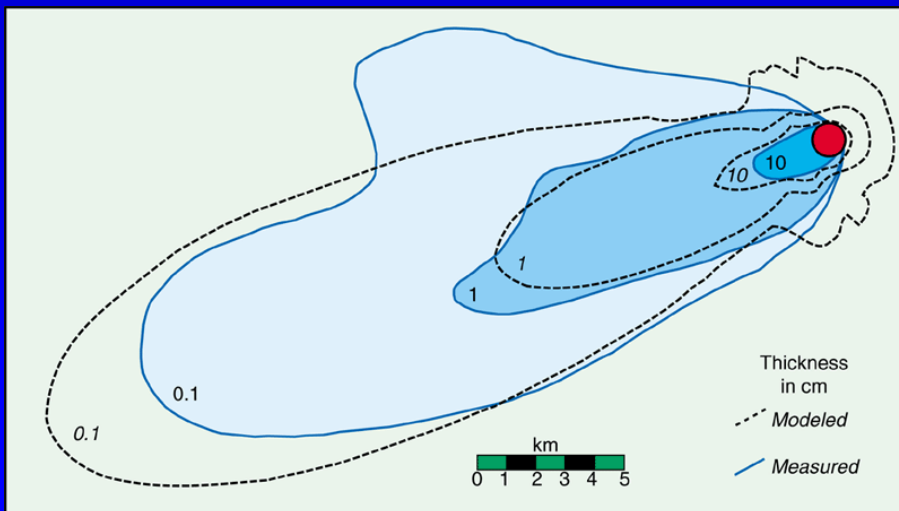
- ◆ **Draft white paper does not cite or discuss important NRC information on the formation of secondary breakouts**
  - Numerical and analog models
  - Field observations
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Limitations in alternative models (e.g., lack of coupling between conduits and breakouts) not addressed**



# Airborne Transport of Tephra



Based on Connor et al. (2001)



Hill et al. (1998)

- ◆ Risk (M): Airborne transport processes to RMEI location
- ◆ Information from models and analog deposits
- ◆ Good support for model performance
- ◆ Parameter uncertainty can be evaluated
- ◆ Basis to evaluate alternative conceptual models



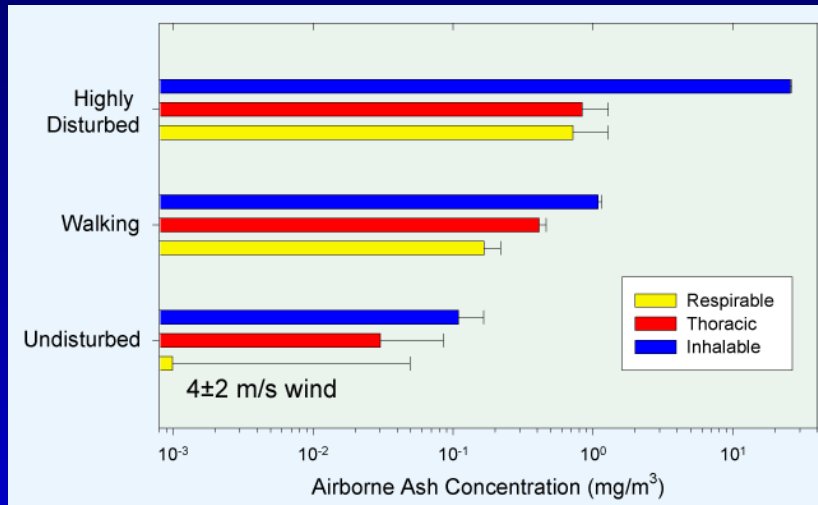
## Highlight of Concerns with ACNW Draft White Paper

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- ◆ **Draft white paper does not cite or discuss important NRC information on the airborne transport of radionuclides**
  - **Model support and sensitivity**
  - **Models for waste entrainment and eruption columns**
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Limitations in alternative models (e.g., lack of model support for a gaussian plume) not addressed**



# Inhalation of Contaminated Tephra



Based on Hill et al. (2001)



- ◆ Risk (H): Concentration of resuspended particles gives inhalation dose to RMEI
- ◆ Information from analog deposits used to develop airborne concentrations
- ◆ Measured airborne particle concentrations are independent of particle sizes in the deposit
- ◆ Effects of alternative information can be reviewed





## Highlight of Concerns with ACNW Draft White Paper

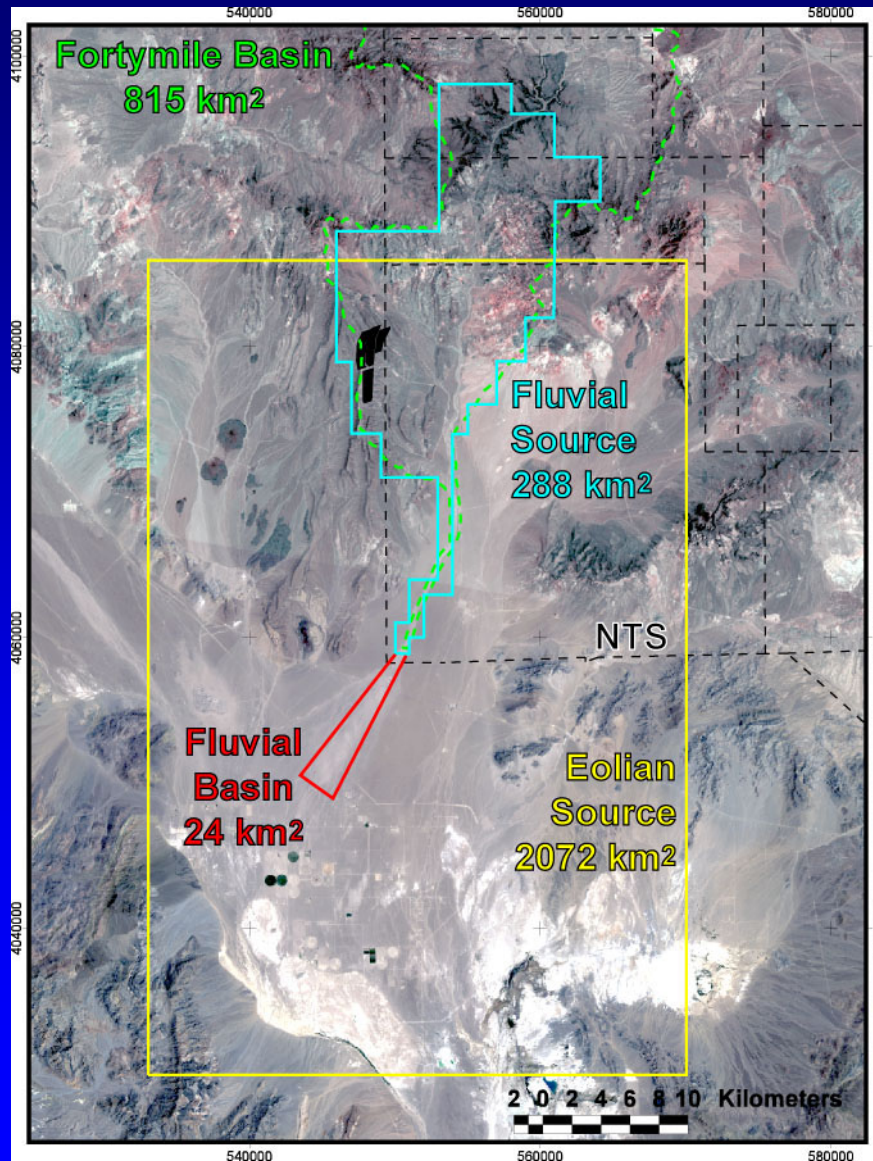
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- ◆ **Draft white paper does not cite or discuss important NRC information on the tephra and waste particle-size distributions**
  - Analog data
  - Characteristics of Yucca Mountain region
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Risk significance of alternative conceptual models or alternative size ranges not addressed**





# Long-Term Redistribution of Radionuclides



Based on Benke et al. (2006)

- ◆ Risk (M): How much tephra might move down Fortymile Wash after a potential eruption?
- ◆ Analog information is abstracted for site-specific model using sediment mass-balance approach
- ◆ Sediment balance approach captures average long-term redistribution processes using site-specific information
- ◆ Effects of parameter uncertainty can be reviewed



## Highlight of Concerns with ACNW Draft White Paper

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- ◆ **Draft white paper does not cite or discuss important NRC information on the long-term redistribution of potential tephra deposits**
  - Analog information
  - Characteristics of Yucca Mountain region
- ◆ **Risk significance not provided for ACNW disagreements with NRC information**
- ◆ **Limitations in alternative models (e.g., single events versus time-averaged flux) not addressed**



## Conclusions

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- ◆ **Sufficient information currently is available to support staff review of the potential DOE license application for igneous activity consequences**
- ◆ **ACNW draft white paper does not address relevant information developed by NRC in each area discussed**
- ◆ **ACNW draft white paper does not include consideration of risk insights and model sensitivities**
- ◆ **ACNW draft white paper does not address limitations in alternative conceptual models**



# DISCLAIMER

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- ◆ **The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or of the acceptability of a license application for a geologic repository at Yucca Mountain.**