

# PLUME-RIDGE INTERACTIONS

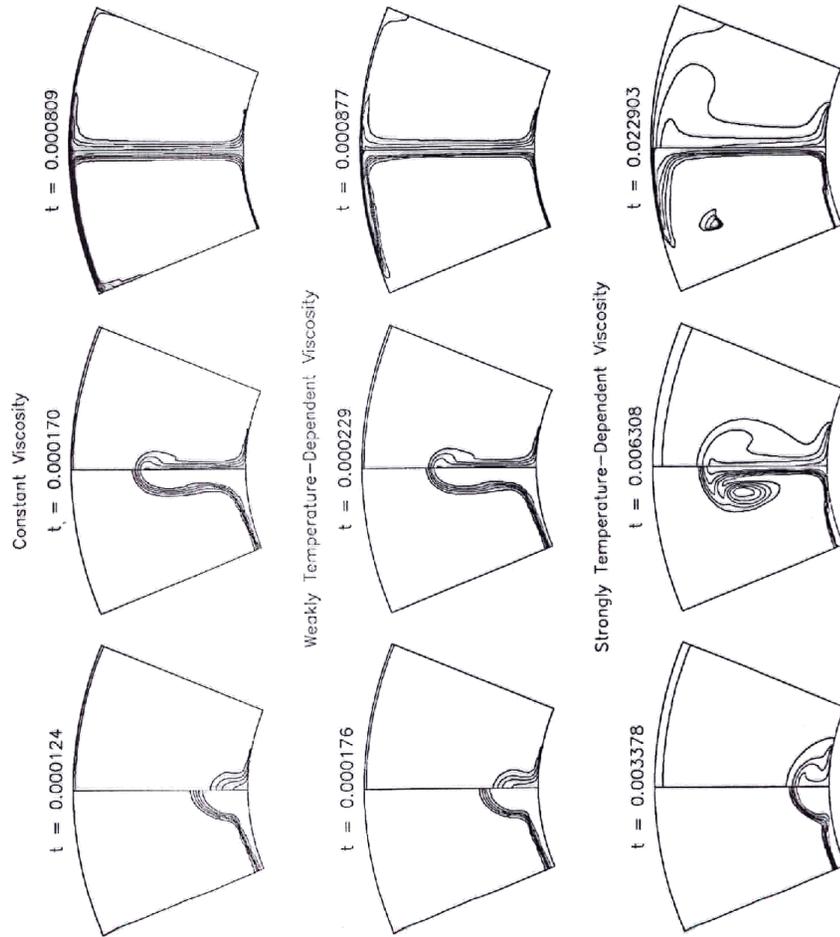


Fig 3

- PLUME3D -  
w/ Mark Feighner & Bryan Travis

Finite difference code for isoviscous flow of thermal and chemical buoyancy in 3-D Cartesian geometry  
[written by Bryan J. Travis, LANL]

**Momentum Equation in dimensionless terms:**

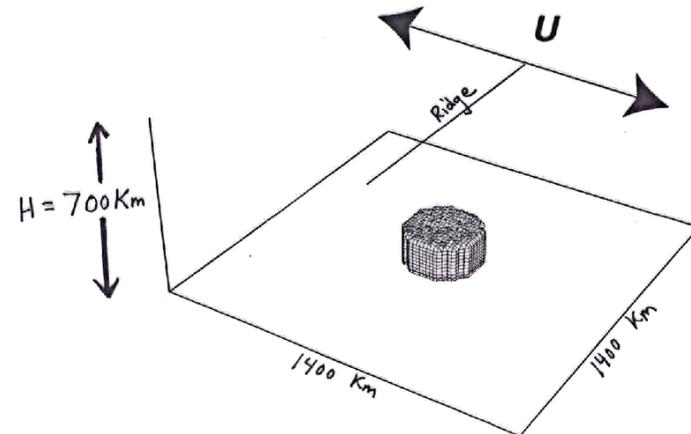
$$\nabla^4 \Gamma = -Ra_c C$$

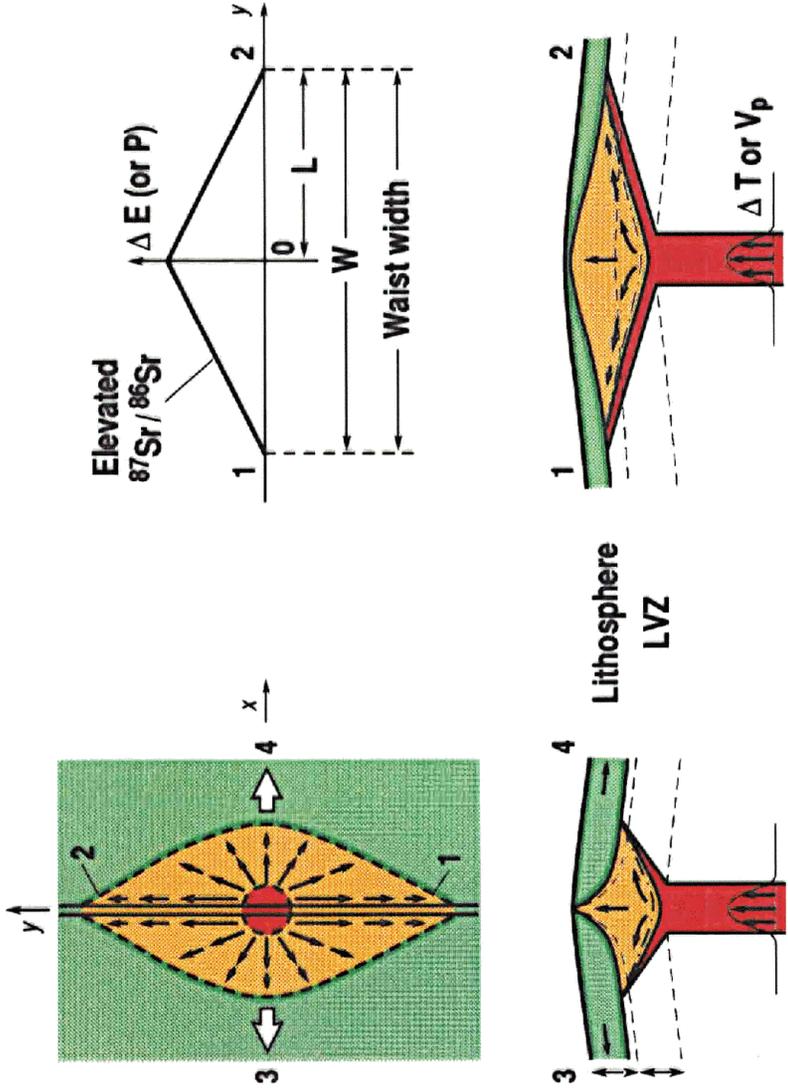
**where:**

$\Gamma =$  Stream Function

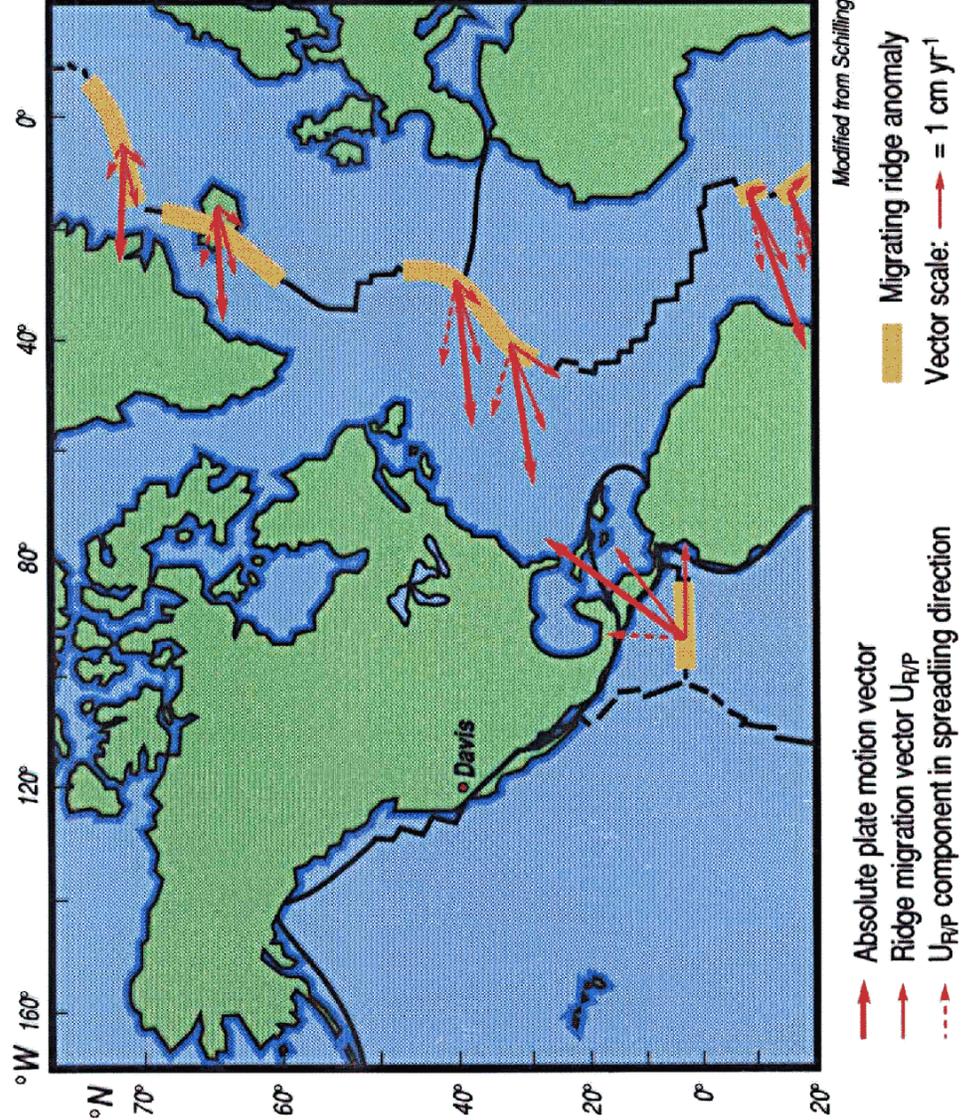
$$Ra_c = \text{Compositional Rayleigh Number} = \frac{\Delta \rho g H^3}{\kappa \eta}$$

$C =$  Concentration of Particles





Modified from Schilling



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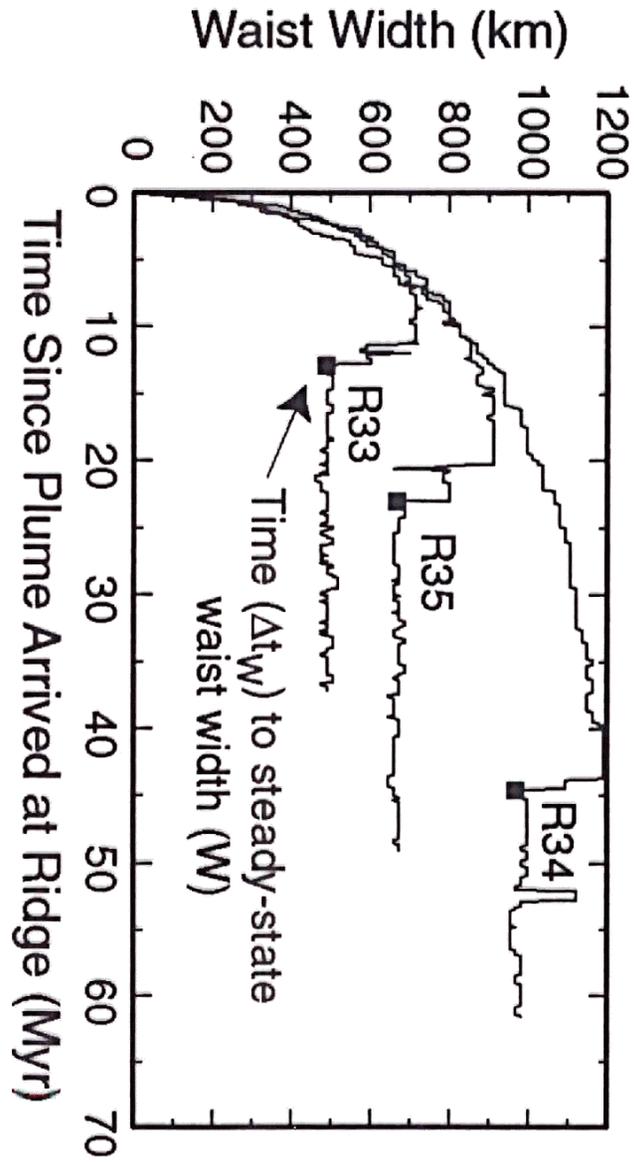
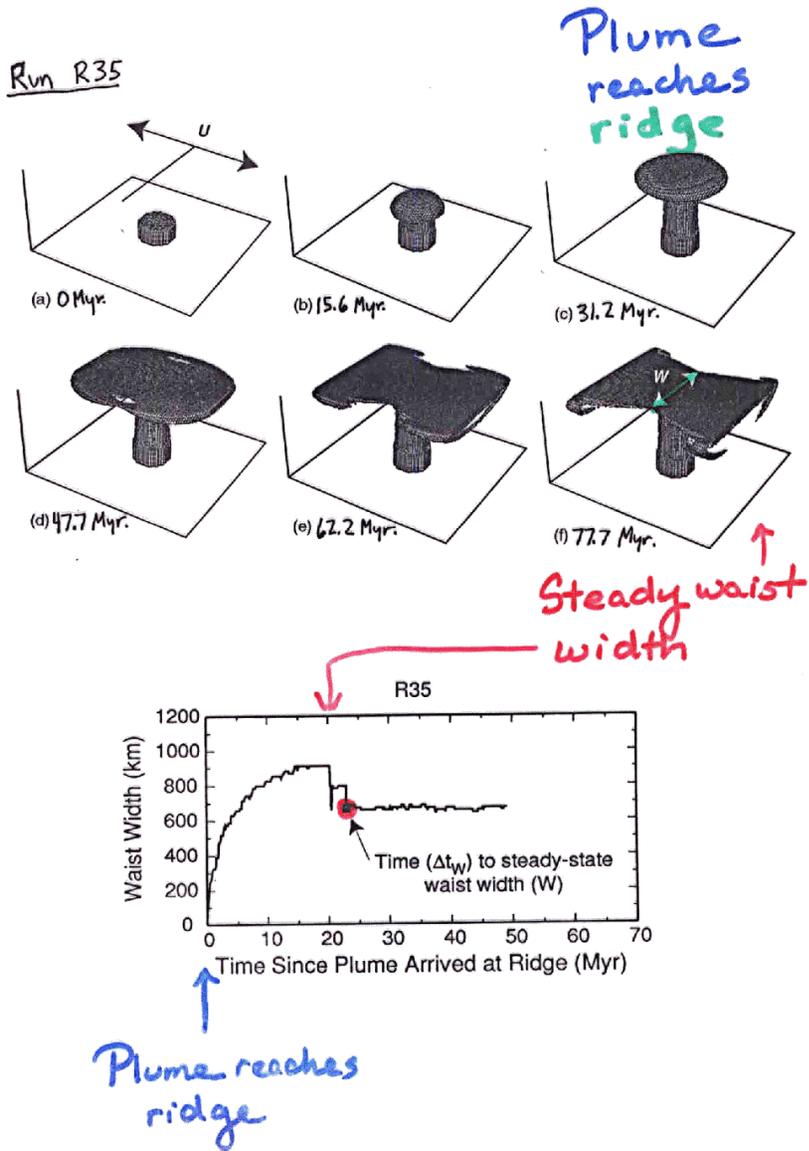
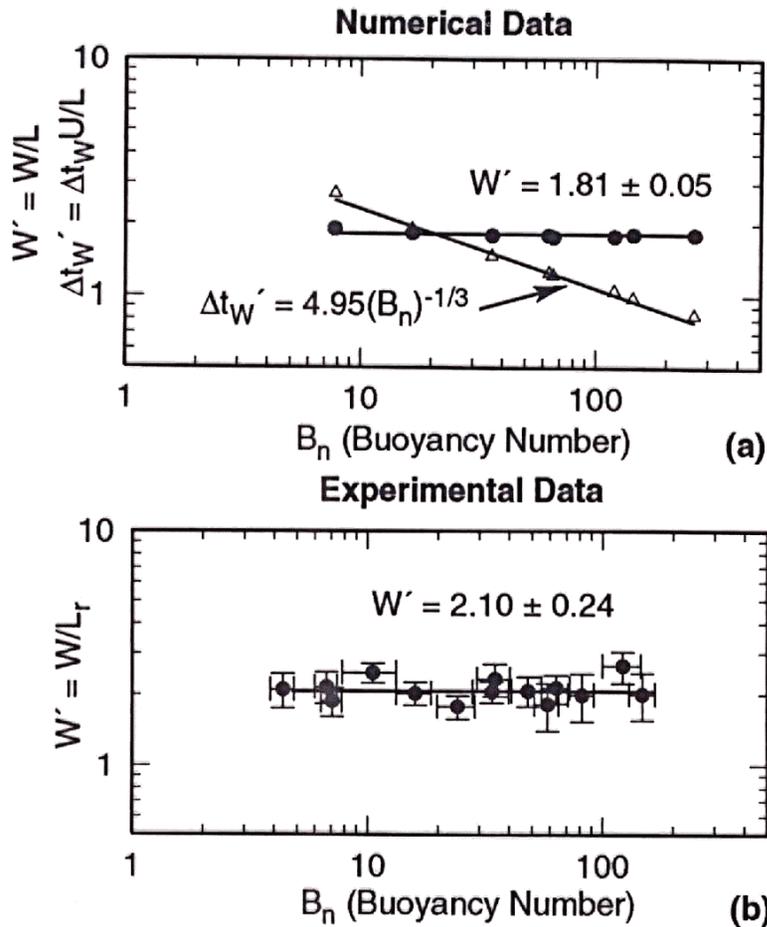


Figure 2. The waist width is plotted as a function of time from arrival of the first plume particle at the ridge for runs R33, R34, and R35.

we can apply the steady-state waist width equation (2), we must determine whether the plumes have reached a steady-state width. To do this, we must have an estimate of the density contrast and  $Q$ . Schilling [1991] gives a method of calculating the flux, assuming that the topography is in isostatic equilibrium, based on Sleep [1990], as

$$Q = WU\Delta E(\rho - \rho_w)/2\rho\alpha\Delta T \quad (4)$$



**Figure 3.** (a) The dimensionless waist width,  $W'$ , was found to be independent of the buoyancy number and the dimension-

**Near-ridge Mantle Plumes and Calculated Parameters**

Plume	Time needed to Reach W $\Delta t_w$ (Myr)	Volumetric Flux Q ( $\text{km}^3 \text{ yr}^{-1}$ )	Volumetric Flux <sup>a</sup> Q ( $\text{km}^3 \text{ yr}^{-1}$ )
Iceland	27	4.94	3.08
Afar	27	5.83	2.86
Jan Mayen	26	2.26	1.26
Azores	21	8.99	2.50
Galápagos	11	14.23	3.56

<sup>a</sup>From Schilling [1991].

All these plumes are older, so they have reached W

This model Q

↑ Independent estimate Q (Schilling)