Conclusions: Because of an unusual likelihood of ocean spills associated with an unusually large number of rift to ocean basin transitions and also because of possible spills into a then-isolated Arctic Ocean basin, the 20 m.y. interval bracketing 65 Ma may have been a time of unusually frequent episodes of sudden sea-level fall and for that reason an interval of episodic, rapid, environmental change.

Discriminating the effects of the great Chicxulub impact from this background of repeated catastrophe represents a challenge that is likely to require the collaborative efforts of a variety of specialists including geochemists, paleobiologists, stratigraphers, and tectonicians. The two different kinds of catastrophe should have had recognizably different effects on sea level, on the environment, and on biota. Extinction of some life forms would be a feature common to both kinds of catastrophe.

Possible effects on sea level from rift initiation have been analyzed by Cathles and Hallam [6]. The model presented here is somewhat different and indicates some specific examples as research targets. Testing the model, especially by studying the sequence stratigraphy of the deeply buried sediments deposited during rift to ocean transitions, may prove feasible.

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IN SEARCH OF NEMESIS.

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The Nemesis model [1] was proposed in 1984 to account for a reported periodicity in mass extinctions [2]. In this model a companion star (probably a red dwarf) orbiting the Sun at a distance of about 3 light years triggers a comet shower once per orbit. This theory contained the first proposal that apparently extended extinctions could in fact be a series of stepwise events in a comet shower [see 3].

Since the original proposal, both the periodicity and self-consistency of the Nemesis theory has been strongly debated. In detailed Monte Carlo simulations, Hut [4] concluded that the orbit was stable for about 1 g.y., consistent with the original model [1]. However, others argued that the orbit was unstable. Clube and Napier [5] argued that the effects of giant molecular clouds (GMCs) dominate and decrease the lifetime to about 0.1 g.y. However, Morris and Muller [6] pointed out that most GMCs are too diffuse to have such an effect and that gravitational scattering from randomly passing stars dominates. Other authors assumed that a 1-g.y. lifetime was too short to be compatible with the nearly 5-g.y. lifetime of the solar system; however, the original paper [1] argued that the lifetime at formation was approximately 5 g.y., and has been decreasing linearly ever since; see, for example, Hut [4]. For more details on this debate, see Perlmutter et al. [7].

What to Look For—Red Dwarfs: The parallax of all stars of visual magnitude greater than about 6.5 has already been measured. If Nemesis is a main-sequence star 1 parsec away, this requires Nemesis's mass to be less than about 0.4 solar masses. If it were less than about 0.05 solar masses it's gravity would be too weak to trigger a comet storm [1,3]. If Nemesis is on the main sequence, this mass range requires it to be a red dwarf.

A red dwarf companion would probably have been missed by standard astronomical surveys [8]. Nearby stars are usually found because they are bright or have high proper motion. However, Nemesis's proper motion would now be 0.01 arcsec/yr, and if it is a red dwarf its magnitude is about 10—too dim to attract attention.

Unfortunately, standard four-color photometry does not distinguish between red dwarfs and giants. So although surveys such as the Dearborn Red Star Catalogue list stars by magnitude and spectral type, they do not identify the dwarfs. We therefore must scrutinize every star of the correct spectral type and magnitude.

Our candidate list is a hybrid; candidate red stars are identified in the astrometrically poor Dearborn Red Star Catalogue and their positions are corrected using the Hubble Guide Star Catalogue. When errors in the Dearborn catalogue make it impossible to identify the corresponding Hubble star we split the fields so that we have one centering on each possible candidate. We are currently scruti-

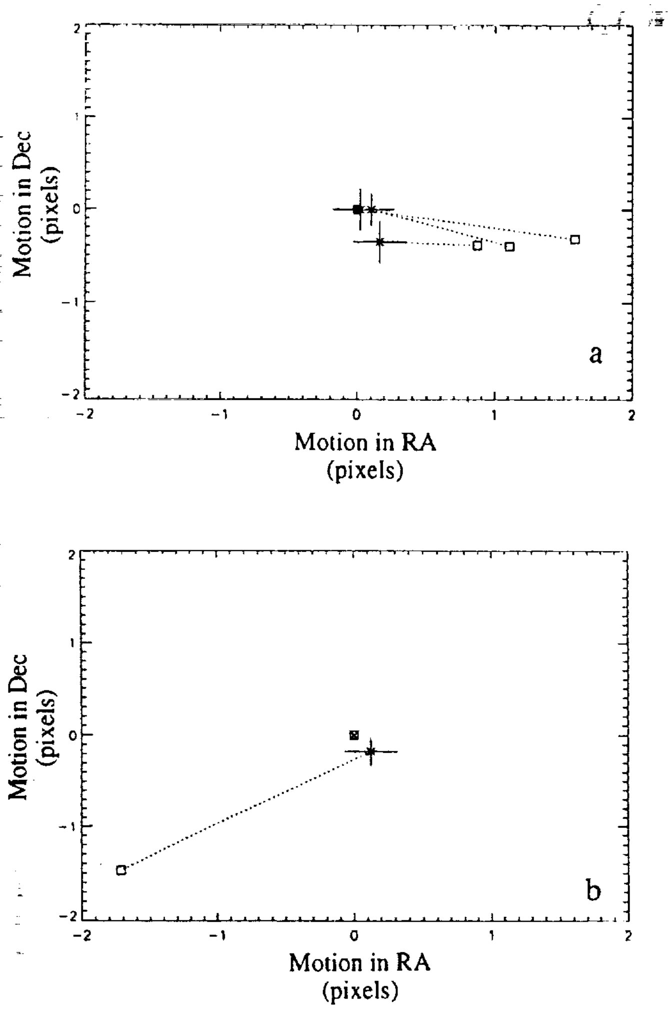

Fig 1. (a) Shows the relative positions measured for one candidate on four different nights. Squares show the expected locations of a star at 1 parsec on the same night. Dashed lines match data to expectations. Data is consistent with a distant star, not with Nemesis. (b) Shows a star that can be rejected with only two observations.

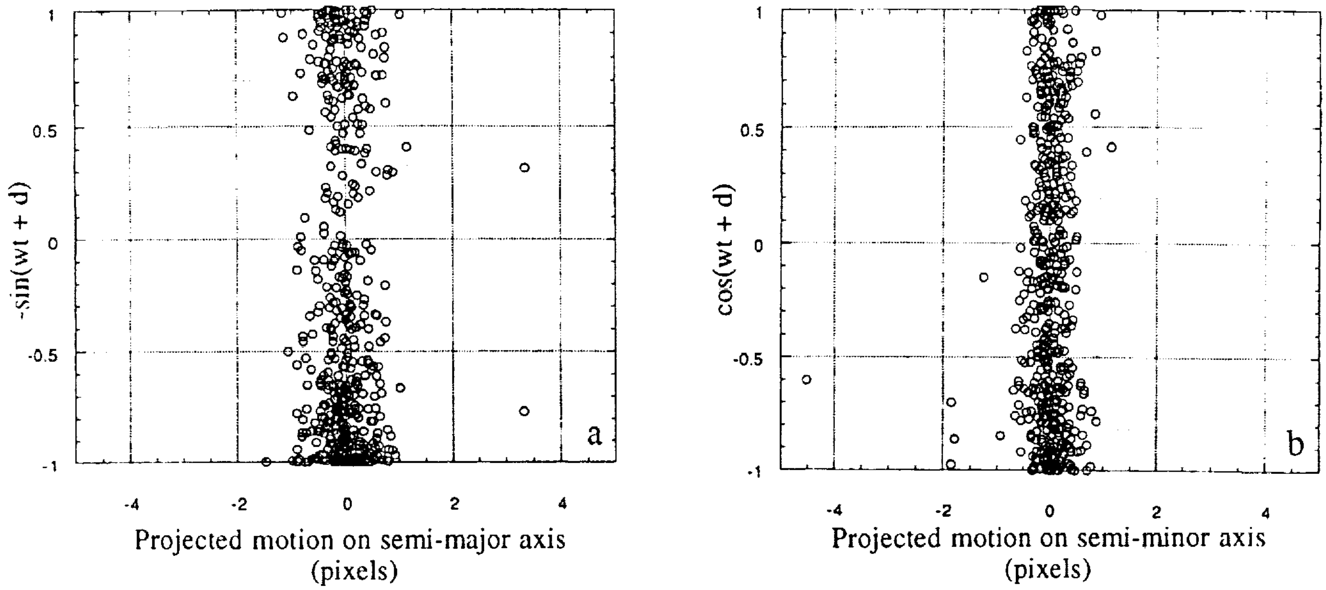

Fig. 2. Summarizes the data as of October 1993. (**a**) Shows the projected motion of all candidates along the semimajor axis of their parallax ellipse and (**b**) shows the motion along the semiminor axis vs. the relevant trigonometric factors. Nemesis should fall on a straight line in both plots.

nizing 3098 fields, which we believe contain all possible red dwarf candidates in the northern hemisphere.

Since our last report [7] the analysis and database software has been completely rebuilt to take advantage of updated hardware, to make the data more accessible, and to implement improved methods of data analysis. The software is now completed and we are eliminating stars every clear night.

Finding Nemesis: A star at 3 light years would display a parallactic motion of 2.5 arcsec over 6 months. We are collecting digitized images of 6 × 6 arcmin fields centered on each of the candidate stars. Images of each star are taken several months apart and aligned using the field stars. The candidate's apparent motion is then measured. The plate scale of our CCD is 0.7 arcsec per pixel and we can routinely locate the centriod of a candidate to within 0.2 pixels. Thus, Nemesis's peak-to-peak displacement should be discernible at about the 18 σ level.

Figure 1 shows two candidates that have been eliminated. The data mark the candidate's motion in pixels (zero is defined as the location at which it was first observed) on different nights. Also plotted (squares) are the locations at which a star at 1 parsec would be expected to be on the same nights. The dashed lines show which measurements go with which squares. Figure 1a summarizes four measurements. Figure 1b shows that we can easily eliminate candidates with only two observations.

Figure 2 summarizes the data taken as of October 1993. Measured along the semimajor axis a star executes a motion given by $P_{major} = -(1/d)\sin(wt + d)$, where d is the distance to the object in parsec, $w = 2\pi/365$ days, t is the time between observations in days. The phase angle d is set by the date of the first observation. The motion along the semiminor axis is given by $P_{minor} = [(1/d)|\sin(L)|]\cos(wt + d)$ where L is the heliocentric latitude of the candidate. The plots show the observed motion for all the candidates projected along the semimajor and semiminor axes of their respective parallax ellipses vs. the relevant trigonometric factors. Observations of a nearby star should fall on a straight line through the origin. For Fig. 2a the slope will be equal to the distance in parsec. For Fig. 2b it is the distance in parsec divided by sin(L).

At present we are limited only by available observing time. When this abstract was written we were eliminating typically 10 candidates every clear night.

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NEW MINERALOGICAL AND CHEMICAL CONSTRAINTS ON THE NATURE OF TARGET ROCKS AT THE CHICXULUB CRATER.

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The Chicxulub Crater melt rocks are being found to display striking mineralogical and chemical features. The most important mineralogical and textural features are related to (1) partial melting of the rock and the preexisting minerals (quartz, plagioclase, and anhydrite), and (2) textural features developed in pyroxenes, feldspars, and magnetite that provide clues to the crystallization behav-