CERI 8315 Geodynamics:

Homework 3

Due in class on Wednesday, October 25, 2023

1. (a) (5 points) Find the similarity structure of the fundamental solution to the following one-dimensional non-linear diffusion equation and suggest a functional form of the solution:

$$\begin{aligned} u_{xx} - u\,u_t &= \delta(x)\delta(t), \quad -\infty < x < \infty, \quad 0 \le t < \infty, \\ u(x,t) &= 0, \text{ as } |x| \to \infty, \\ u(x,0) &= 0. \end{aligned}$$

   (b) (10 points) Choose a suitable similarity variable based on your answer above and derive the ordinary differential equation in terms of the similarity variable.

2. Read the paper by McKenzie et al. (EPSL, 2005) (distributed with this homework) and submit a $\sim$1-page, three-paragraph summary. The three paragraphs should summarize
   (a) (10 points) the problem,
   (b) (10 points) the chosen approach to the problem,
   (c) (10 points) and the new findings.

3. (10 points) Solve Problem 4.10 in T&S.

4. (10 points) Solve Problem 4.29 in T&S.

5. (5 points) Reproduce Fig. 4.25 in T&S using matplotlib for Python and the heat flow data provided in the next page. Submit your plotting code as a file to Canvas.

TABLE 1. Mean And Standard Deviations Of Heat Flow Data In Selected Well-Sedimented Areas of Known Age In The Pacific

Area	Age Range m.y. B.P.	No. of Stations	Mean, μcal/cm^2 s	s.d., μcal/cm^2 s	Standard Error	s.d.*
a	120-140	30	1.13	0.14	0.03	12
b	90-100	8	1.57	0.15	0.05	9
c	80-90	18	1.36	0.24	0.06	17
d	15-20	7	2.40	0.58	0.22	24
e	5-10	6	4.21	0.51	0.21	13
f	5-10	4	3.97	0.41	0.21	11
g	5-10	10	4.12	0.46	0.15	12
h	10-20	9	2.85	0.52	0.17	18
i	35-75	6	0.92	0.48	0.20	52
j	3.5-7	24	5.72	2.30	0.47	40
k	3-4	4	6.40	2.90	1.40	45

a, northwestern Pacific; b, east of Hawaii; c, north of Hawaii; d, equatorial Pacific 114°W; e, north of Galapagos spreading center; f, south of Costa Rica rift; g, combination of e and f; h, south of Carnegie ridge; i, equatorial Pacific 130°W-150°W; j, Explorer ridge 49°N; k, Juan de Fuca ridge 47°N.

*As percent of mean value.

From Sclater, et al., 1976

Table 3. Heat flow and age for selected sites on old ocean floor.

Area	Lat.	Lon	No. Penet.	Age[5] (Ma)	Heat Flow (mW/m^2)	Error (90%)
WC Pacific 1[1]	12°N	151°E	32	168-172	46.8	0.5
WC Pacific 2[2]	13.5°N	157°E	18	175-195	49.4	0.2
WC Pacific 3[2]	8°N	164°E	14	163-167	44.2	0.9
WC Pacific 4[2]	9°N	179°E	8* (5)*	142-150	49.5* (57.5*	1.1* 4.1*)
NW Pacific a[3]	35-50°N	145-170°E	30	120-140	47	2.0
WN Atlantic 1[4]	25°N	68°W	42	118-120	47	1.0
WN Atlantic 2[4]	27°N	71-72°W	55	148-151	49	1.0
WN Atlantic 3[4]	28°N	74°W	24	158-162	47	2.0
WN Atlantic 4[4]	28°N	75°W	22	163-167	49	1

1: This study, average of Stations 2 & 3.
2: This study.
3: Sclater et al. (1976).
4: Davis et al. (1984).
5: All ages recalculated from Kent and Gradstein (1986) assuming M37 at 170 Ma.
*: Both sets of data are reported.

From Lister, et al., 1990