

DISTRIBUTION AND SOURCE APPORTIONMENT OF
ELEMENTS IN URBAN SOIL OF KUALA
TERENGGANU, MALAYSIA

POH SENG CHEE

MASTER OF SCIENCE
UNIVERSITI MALAYSIA TERENGGANU
MALAYSIA

2008

**DISTRIBUTION AND SOURCE APPORTIONMENT OF ELEMENTS IN
URBAN SOIL OF KUALA TERENGGANU, MALAYSIA**

POH SENG CHEE

**Thesis Submitted in Fulfillment of the Requirement for the Degree of Master of
Science in the Faculty of Science and Technology
Universiti Malaysia Terengganu**

March, 2008

To my beloved country; Malaysia

Happy 50th Year of Independent

~31 August 2007~

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirement of the degree of Master of Science.

**DISTRIBUTION AND SOURCE APPORTIONMENT OF ELEMENTS IN
URBAN SOIL OF KUALA TERENGGANU, MALAYSIA**

POH SENG CHEE

2008

Chairperson : Norhayati Mohd Tahir, Ph.D.

Member : Noor Azhar Mohamed Shazili, Ph.D.

Faculty : Science and Technology

An environmental geochemical investigation was carried out in the area of Kuala Terengganu district (latitude of 05° 10'N to 06° 25'N and longitude of 102° 59'E to 103° 14'N) to produce data and GIS-based maps of element distributions in the soils. Two hundred and forty five soil samples were collected based on a density of 8-16 sub-samples per km² from the top 15 cm of the soil. The total concentrations of 14 elements (Al, Ca, K, Fe, Na, Mg, Cd, Co, Cr, Co, Mn, Ni, Pb and Zn) were determined by aqua regia/ hydrofluoric acid microwave digestion followed by inductively coupled plasma-optical emission spectrometry (ICP-OES) analysis. Results from the analysis showed that the range concentrations of these elements were 0.14-1.44 % Al, 0.01-1.17% Ca, 0.22-7.7% Fe, 0.08-2.09% K, 0.002-0.72% Mg, 0.04-3.48% Na, 0.38-6.78 mg Cd/kg, <0.05-35.8 mg Co/kg, 3.05-50.1 mg Cr/kg, 0.82-148 mg Cu/kg, 2.54-356 mg Mn/kg, 1.91-16.7 mg Ni/kg, 2.54-160 mg Pb/kg and 4.61-204 mg Zn/kg respectively. In general, the mean concentrations of these elements fall within the range concentrations values of the world average. However, some elements (Cd, Co, Pb and Zn) were present in relatively high concentrations in some areas of Kuala Terengganu. These elements' concentrations

ranged from background levels to levels in excess of Dutch Target guideline values and Australia's environmental investigation levels (EILs). Multivariate statistics and GIS techniques were applied to classify the elements and to identify these sources of elements. Principal component analysis (PCA) and cluster analysis (CA) classified the elements into three groups. The first group (Cd, Co, Ni, Cr, Fe, Pb, Cu and K) represented the variation of the elements' concentration in Kuala Terengganu soil, the second group (Al, Na, Ca and Mg) was predominantly derived from natural sources and the third group (Mn, Zn, Pb and Cu) was influenced by human activities. In addition, a GIS-based mapping technique was adopted to create the spatial distribution of geochemical anomalies in Kuala Terengganu soils. The results showed that the hotspot areas of metal contamination (Zn, Pb, Cu and Mn) were mainly concentrated in the town area and other urban parts of Kuala Terengganu, and was closely related to high traffic conditions. The study also indicated that using an enrichment factor as a way to fingerprint the source of heavy metals in soils cannot conclusively differentiate the anthropogenic and geogenic elements' sources.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
sebagai memenuhi keperluan untuk ijazah Master Sains.

**TABURAN DAN PUNCA UNSUR DALAM TANAH BANDAR DI KUALA
TERENGGANU, MALAYSIA**

POH SENG CHEE

2008

Pengerusi : Norhayati Mohd Tahir, Ph.D.

Ahli : Noor Azhar Mohamed Shazili, Ph.D.

Fakulti : Sains dan Teknologi

Penentuan kandungan unsur dalam tanah telah dijalankan di kawasan Kuala Terengganu (latitud 05° 10'N ke 06° 25'N dan longitud 102° 59'E ke 103° 14'N). Dua ratus empat puluh lima sampel tanah atas (0-15cm) telah dikumpulkan dengan kepadatan 8-16 sub sampel per km². Unsur-unsur yang dikaji adalah Al, Ca, K, Fe, Na, Mg, Cd, Co, Cr, Co, Mn, Ni, Pb dan Zn. Komposisi unsur-unsur dalam sampel tanah diekstrak dengan menggunakan kaedah penghadaman gelombang mikrowave dengan campuran asid *aqua regia* dan asid hidrofluorik. Kandungan unsur dalam larutan ekstrak tanah ditentukan dengan menggunakan alat spektrometri pemancaran optik aruhan gandingan plasma (ICP-OES). Hasil analisis menunjukkan purata kepekatan unsur-unsur yang dikaji ialah masing-masing 0.14-1.44 % Al, 0.01-1.17% Ca, 0.22-7.7% Fe, 0.08-2.09% K, 0.002-0.72% Mg, 0.04-3.48% Na, 0.38-6.78 mg Cd/kg, <0.05-35.8 mg Co/kg, 3.05-50.1 mg Cr/kg, 0.82-148 mg Cu/kg, 2.54-356 mg Mn/kg, 1.91-16.7 mg Ni/kg, 2.54-160 mg Pb/kg dan 4.61-204 mg Zn/kg. Secara keseluruhannya, purata kepekatan unsur-unsur dalam tanah kajian masih berada dalam julat purata dunia. Bagaimanapun, unsur-unsur seperti Cd, Co dan Zn menunjukkan aras kepekatan yang agak tinggi di beberapa kawasan di Kuala Terengganu. Julat

kepekatan bagi unsur-unsur tersebut adalah di antara aras latarbelakang sehingga melebihi 'nilai sasaran Dutch' dan aras penyiasatan persekitaran Australia (EILs). Analisis statistik multivariat dan kaedah GIS digunakan untuk menunjukkan unsur-unsur yang dikaji dapat dikelompok mengikut sumber geokimia masing-masing. Analisis komponen utama (PCA) dan analisis berkelompok (CA) berjaya mengkategorikan unsur-unsur yang dikaji kepada tiga kelompok dimana kelompok pertama (Cd, Co, Ni, Cr, Fe, Pb, Cu dan K) mewakili variasi kepekatan unsur-unsur dalam tanah Kuala Terengganu, kelompok kedua (Al, Na, Ca dan Mg) didominasi oleh unsur-unsur yang berpunca dari sumber semulajadi dan unsur-unsur dalam kelompok ketiga (Mn, Zn, Pb dan Cu) adalah dipengaruhi oleh aktiviti manusia. Tambahan pula, teknik GIS diguna untuk memeta taburan unsur-unsur dalam tanah Kuala Terengganu. Hasil dari analisa menunjukkan tiga *hotspot* telah dikesan di kawasan bandar Kuala Terengganu yang sering berhubungan rapat dengan kadar lalu-lintas yang tinggi di kawasan-kawasan tersebut. Selain itu, kajian ini juga menunjukkan kaedah faktor kekayaan (EF) bukan merupakan satu kaedah yang dapat membezakan dengan nyata/jelas samada sumber unsur-unsur dalam tanah tersebut adalah daripada sumber antropogenik ataupun sebaliknya.