

**HYDROCHEMISTRY OF GROUNDWATER
POLLUTION IN THE URBAN AREA OF KHAN
YOUNIS CITY, GAZA STRIP, PALESTINE**

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AREA OF KHAN YOUNIS CITY, GAZA STRIP, PALESTINE**

by

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً بِقَدَرٍ فَأَسْكَنَّا فِي الْأَرْضِ

وَإِنَّا عَلَى ذَهَابٍ بِهِ لَقَادِرُونَ

المؤمنون (18)

This PhD thesis is dedicated to

"ALLAH's mercy upon" soul of my Father and my Mother

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LIST OF ABBREVIATIONS

BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
CAMP	Coastal aquifer management program
EC	Electrical conductivity
EPA	Environmental Protection Authority (USA)
GMWL	Global Meteoric Water Line
GPS	Geographical positioning system
HWE	House of Water and Environment
IAEA	International Atomic Energy Agency
IRMS	Ratio Mass Spectrometer
LMWL	Local Meteoric Water Line
MOPIC	Ministry of Planning and International Cooperation
MWL	Meteoric Water Line
NICB	Normalized Inorganic Charge Balance
PCBS	Palestinian Central Bureau of Statistics
TDS	Total dissolved solids
TH	Total hardness
UN	United Nation
UN-ESCWA	United Nations Economic and Social Commission for Western Asia
UNEP	United Nation Environmental Program
USSL	United State Salinity Laboratory Staff
VSMOW	Vienna Standard Mean Ocean Water
WHO	World Health Organization

LIST OF SYMBOLS

\bar{x} and \bar{y}	The mean ionic values x and y ions
‰	per mil or per thousand enrichment
^{18}O	Oxygen-18
^2H	Deuterium
A^{2+}	Di-valent cation
a_{A}	Activity of A ion
a_{B}	Activity of B ion
a_i	Activity of ionic species for i^{th} ion
Av.	average
B^+	Mono-valent cation
B^{3+}	Boron ion
$\text{Ca}(\text{HCO}_3)_2$	Calcium bicarbonate
Ca^{2+}	Calcium ion
$\text{Ca}_5(\text{PO}_4)_3\text{F}$	Fluoroapatite
CaCl_2	Calcium chloride
CaCO_3	Calcium carbonate (calcite)
CaF_2	Fluorite
CAI-I	Chloro-alkaline index I
CAI-II	Chloro-alkaline index II
$\text{CaMg}(\text{CO}_3)_2$	Dolomite
$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	Gypsum
Cl^-	Chloride ion
CO_2	Carbon dioxide

CO_3^{2-}	Carbonate ion
CV	Coefficients of variation
D‰	deuterium excess (D–excess) value in parts per mil or per thousand enrichment
Ex	Exchanging substrate in the aquifer and the vadose zone (clay/soil)
F^-	Fluoride ion
f_i	Ionic activity coefficient for i^{th} ion
H^+	Hydrogen ion
H_2CO_3	carbonic acid
H_3PO_3	Boric acid
HCO_3^-	Bicarbonate ion
I	Ionic strength
IAP	Ionic activity product of the mineral–water reaction
K^+	Potassium ion
K_{sp}	Mineral solubility product
Max.	Maximum
Meq/L	Concentration in milliequivalent per liter
$\text{Mg}(\text{HCO}_3)_2$	Magnesium bicarbonate
mg/L	Concentration in milligram per liter
Mg^{2+}	Magnesium ion
MgCO_3	Magnesium carbonate (magnesite)
MgSO_4	Magnesium sulfate
m_i	Concentration (molality) of ionic species for i^{th} ion
Min.	Minimum
Na^+	Sodium ion