



Natural Clays

-- NSP for Life --

Facing the Global Challenges and the Coronavirus Pandemic

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The History of Natural Clays and the Modern Applications  
From ancient clay to 21<sup>st</sup> century NSP (invented by JJ Lin 2003)

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Revealing (the hidden treasures of the sand) - Deuteronomy 33:19)

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2020-3

# The History of Natural Clays and the Modern Applications

## From ancient clay to 21st century NSP (JJ Lin 2003)



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From Egyptian uses of clays for anti-inflammatory, antiseptics and as preservative for making mummies, cures for poison and plague, to NASA space program in 1960' s for calcium supplement, to the modern 21<sup>st</sup> century, scientists are still searching the way of utilizing clay for the "holy grail" material as alternatives to protect mankind and our environment. Although the endeavor is still continuing, our invention of "Nano Silicate Platelets, NSP" may be a step closer to realize the "hidden treasure in the sand" as one of the solutions in facing our global problems including the overuse of pesticides in agriculture, antibiotics in livestock, and disinfectants in environment.

Jiang-Jen (JJ) Lin  
Professor Emeritus, National Taiwan University  
2020-3 during the Covid19 Pandemics

# Facing the Global Challenges and Opportunities

## 人類面對的挑戰與機會

- 石化替代及再生能源 Fossil Fuel vs. Renewable Energy
- 醫藥與醫療 Infectious Virus and Pandemic, Antibiotic Misuse and MRSA Threat  
("細菌/病毒感染傳染與抗生素濫用/多重抗藥性細菌感染")
- 食品安全 (Food Safety)
- 糧食不足/糧食危機 (Food Security)
- 水資源污染 (Water Scarcity)
- 塑膠海洋垃圾及環境(生物鏈)污染 (Ocean Plastics and Environmental Pollution and Rehabilitation )
- 溫室氣體排放減量及CO<sub>2</sub> 再利用 (Global Warming and CO<sub>2</sub> Emission Reduction)

# The History of Natural Clays and Applications

**Historically, clay eating has been associated with treatments for cholera and bacterial infection.**

1. The first recorded use of medicinal clay is on Mesopotamian clay tablets around 2500 B.C.  
Ancient Egyptians used clays as antiseptics and preservative for making mummies.
2. Aristotle (384–322 BC) made the first reference to the deliberate eating of earth, soil, or clay by humans (for **therapeutic and religious purposes**).
3. Marco Polo described how in his travels he saw Muslim pilgrims cure fevers by ingesting 'pink earth' to **relieve famine**.
4. Dating back to Greek , holy clay tablets were widely traded as cures for poison and the plague; and also used in the Roman Catholic Church.

# “Smart” Parrots Lick Clays for Detoxification

Many species of South American parrots have been observed at clay licks, ingesting clays in Papua New Guinea. These parrots regularly eat seeds and unripe fruits containing alkaloids and other toxins. Because many of these chemicals become positively charged in the acidic stomach, they bind to clay minerals which have negatively charged cation-exchange sites, and are thereby rendered safe.

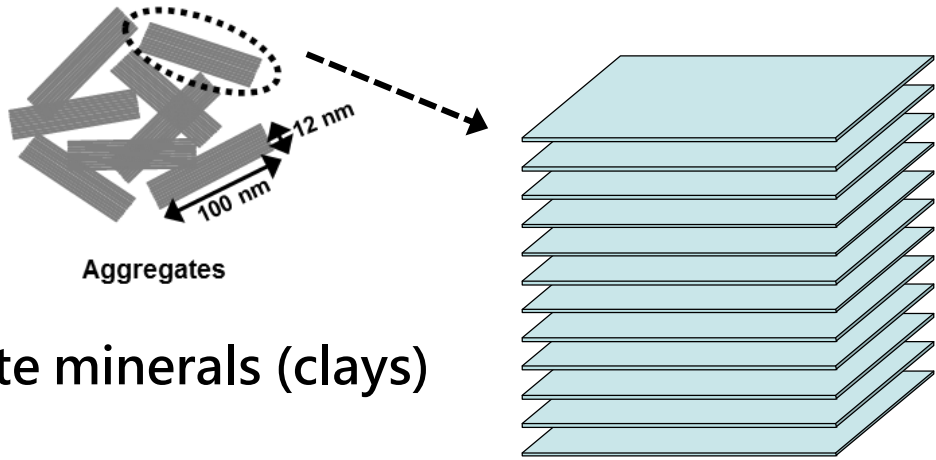


## Modern uses of the natural clays

The benefits of bentonite clay: <https://www.medicalnewstoday.com/articles/325241>

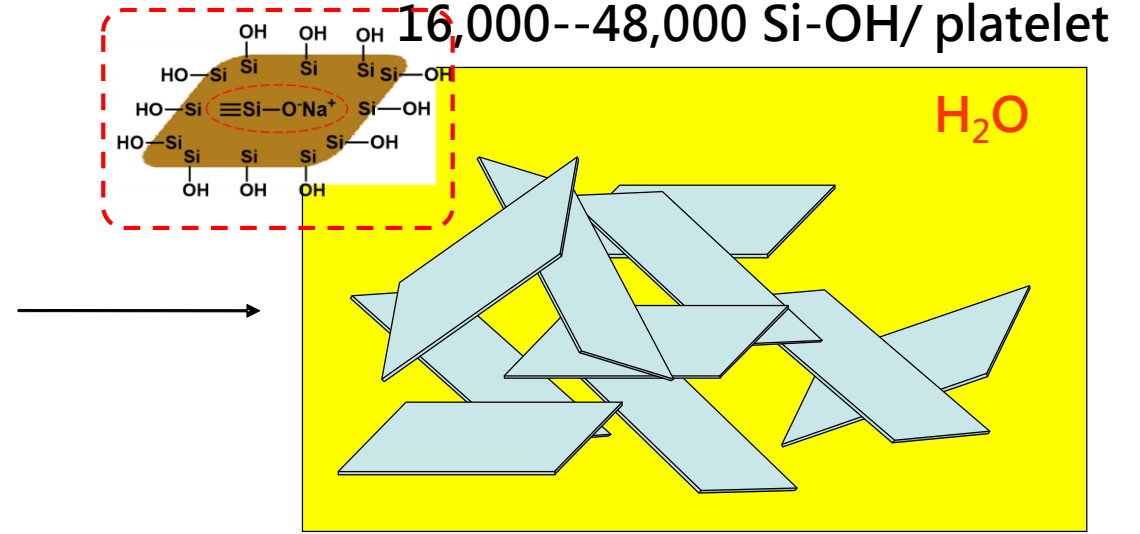
- Pharmaceutical formulations, Oral, Gastrointestinal protectors
- Osmotic oral laxatives
- Anti-diarrheal, detoxifying-removing toxins
- Industrial absorbents
- Dermatological protectors
- Cosmetics, skin treatment
- Drug excipients and in the liberation process of drugs

# Invention of making Nano Silicate Platelets (NSP) from natural clay of microscale layered structure (JJ Lin 2001-2003)



Natural silicate minerals (clays)

(Layered structure)



1.0 nanometer-thin silicate plates in  
water (dispersible)

New Compositions --NSP  
--ionic character (anionic)--  
1.0-nanometer-thickness!  
750 m<sup>2</sup>/g high-surface-area

US Patents: 7 125 916 B2 (2006); 7 442 728 B2 (2008); 7 495 043 B2 (2009); 8 168 698 B2 (2012) to NCHU and NTU "Method for Producing Nano Silicate Plates" .  
JJ Lin. "Intercalation strategies in clay/polymer hybrids, *Progress in Polymer Science (Review Article)*(2014)  
JJ Lin. "First Isolation of Individual Silicate Platelets from Clay Exfoliation" and Their Unique Self-Assembly into Fibrous Arrays, *The Journal of Physical Chemistry B*, (2006)

## Bentonite is one of the raw materials for NSP in 2003 by JJ Lin

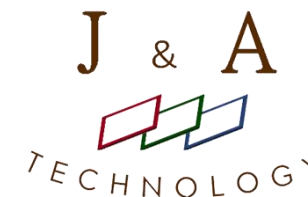
Bentonite: Used by the NASA space program in 1960s  
as the calcium supplements



A mountain of clay--Petrified Forest National Park,  
Arizona. (adopted from Medicinal clay; Wikipedia)

The effects of weightlessness on human body were studied by NASA in the 1960s. Experiments demonstrated that weightlessness leads to a rapid bone depletion. A number of pharmaceutical companies were asked to develop calcium supplements, "the calcium in clay ...is absorbed more efficiently .. [clay] contains some factors promoting calcium utilization and/or bone formation."

# Safety and Low Toxicity of NSP



## Evaluation on Cytotoxicity and Genotoxicity of the Exfoliated Silicate Nanoclay

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**ABSTRACT** The concern about toxicity for nanosilicate platelets (NSP) derived from natural montmorillonite clay is addressed. The NSP nanoclay was isolated from polyamine–salt exfoliation of the layered silicate clay into randomized individual plates, possessing multiple ionic charges on the surface of silicate plates with an average geometric dimension of ca.  $80 \times 80 \times 1 \text{ nm}^3$ . The material had been previously shown to be effective for antimicrobial and tendency for adhering onto the biomaterial surface based on the direct observation by using scanning electron microscope. The material safety on genotoxic effect was investigated by using three different test systems: the Comet assay test on Chinese Hamster Ovary (CHO) cells in vitro, micronucleus (MN) assay in vivo and the *Salmonella* gene mutation assay on strain TA98, TA100, TA102, TA1535 and TA1537. The Comet assay showed no DNA damage after 24 h of incubation with NSP of  $1000 \mu\text{g/mL}$ . The MN test indicated no significant micronucleus induction in the CHO cells at the concentrations tested. With all five strains of *Salmonella typhimurium*, none of mutations was found. Furthermore, cytotoxicity of the same material was assayed by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) and lactate dehydrogenase (LDH) release, showing a low cytotoxicity on CHO cells below  $1000 \mu\text{g/mL}$  after 12 h incubation period and a dose-dependent effect after 24 h incubation. For feeding to rats, the acute oral toxicity was shown a low lethal dose ( $\text{LD}_{50}$ ) or greater than  $5700 \text{ mg/kg}$  body weight for both male and female Sprague-Dawley rats. Overall, the study has demonstrated the safety of the NSP for potential uses in biomedical areas.

**KEYWORDS:** nanosilicate platelets • cytotoxicity • genotoxicity • nanomaterials • acute oral toxicity

The safety of NSP with respect to cytotoxicity and genotoxicity has been evaluated.

1. A low lethal dose ( $\text{LD}_{50} > 5,700 \text{ mg/kg}$  to rats or similar to NaCl) was found.

2. Low cytotoxicity (1000 ppm on CHO cells) and none of genotoxicity were reported.



Natural Clays

## The Invention of NSP (Natural Silicate Platelets)

NSP Enabling Diverse Functions of Antimicrobial, Antivirus, Detoxification and the Synthesis of High-Surface-Supported Nanohybrids of NSP-AgNP, ZnO, CuO and Fe<sub>3</sub>O<sub>4</sub> nanoparticles

Consequently Rendering a host of Applications :

1. In agriculture (pesticide-substitute, plant growth promoter, water/soil pollution remedy)
2. In livestock (detoxification and Anti-Bird-Flu) and in aquaculture (water cleaning)
3. In medical uses (anti-MRSA, anti-biofilm and hemostatic agent)

「天然矽片」NSP -- 抗菌/抗病毒/去毒素/多方面功能; 高度表面積吸附奈奈米金屬粒子, 可廣泛應用於農業、畜牧漁、水質/土壤/環境、醫藥/保健食品 等

## The NSP Diverse Applications

"Zero-Insecticide" Agricultures (新農藥)

"Zero-Antibiotics" Livestock (無感染養殖畜牧漁業)

Soil/Water Environmental Cleanliness (自然環境保護)

1. "Zero-Pesticide" Agricultures: free of Insecticides, Absorbing Organic Toxins, Inorganic Heavy Metals, etc. (零農藥農作物生長、吸附無毒素及重金屬等)
2. "Zero-Antibiotics" Livestock: free of Antibiotics in Poultry (零抗生素) and Inhibiting virus-infection or bird flu (抑止病毒傳播、禽流感)
3. Crop Protection from Diseases, Insects, Bacteria, Virus, Fungi, etc.(預防作物疾病)
4. Seed Protection from Frost (種子抗寒、抗凍)
5. Plant Growth Promoter and Soil Remediation (促進植栽生長)(土壤改質)
6. Bacterial and Toxin Removal from Contaminated Water (汙染水質整治) and Environmental Cleanliness (環境汙染清潔)
7. De-odorant spray and detergency enhancer (除臭)(清潔)
8. Anti-virus (bird flu and African swine fever) (抗禽流感/豬瘟)

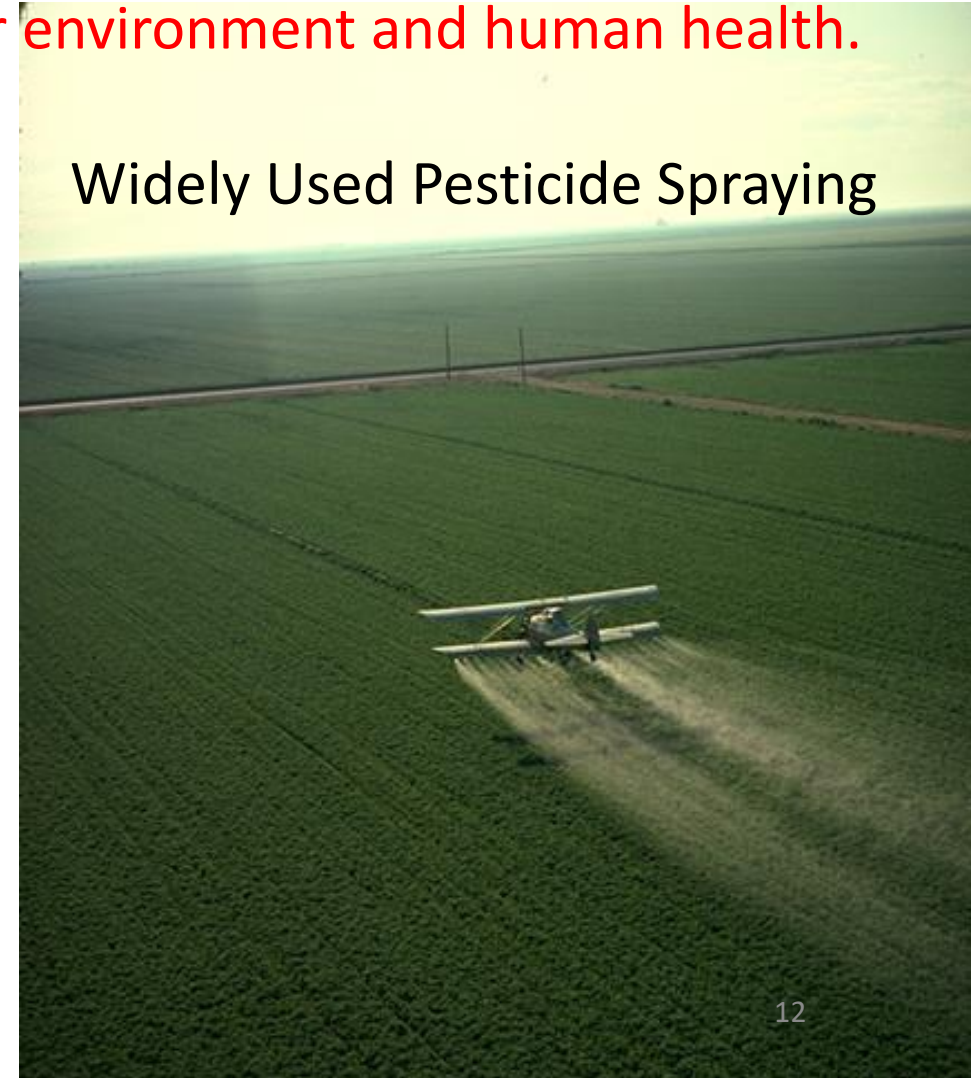
## NSP can mediate the overuse of organic pesticides

1. Pesticides: synthetic herbicides, insecticides, fungicides e.g., DDT; Carson's 1962 book "Silent Spring"  
(除虫 / 除草化學藥物環境汙染 )
2. Alternatives: genetically modified plants, biological substances (基因改質/微生物/生化藥劑 )
3. Ongoing problem of pesticide residue in foods and soils  
(農藥殘留)



The overuse of pesticides and chemicals including synthetic herbicides, insecticides, fungicides, organic drugs and heavy metals become a serious problem in our environment and human health.

### Widely Used Pesticide Spraying



For further consultation

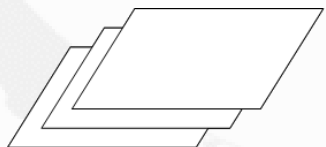
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